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ON THE ACCURACY OF FLECHETTES BY DYNAMIC WIND TUNNEL TESTS, BY THEORY AND ANALYSIS, AND BY ACTUAL FIRINGS

January 1975

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Munitions Development & Engineering Directorate

U.S. ARMY ARMAMENT COMMAND
FRANKFORD ARSENAL
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Jump angle	Flechette dispersion theory

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The accuracy and dispersion of flechettes are investigated 1) by an exploratory firing program, 2) by a supersonic dynamic testing wind tunnel program, 3) by development of a theory for jump and dispersion for computer computation and analysis and 4) by precision range firings at Frankford Arsenal.

The exploratory firing program reveals the importance of fin and body damage, the blast region, and saboting. The dynamic wind tunnel program

20. ABSTRACT (Cont'd)

yields the static and dynamic aeroballistic stability coefficients on various flechette designs. The theory and analysis program has presented the effects of the initial launching conditions, the various stability coefficients and asymmetries and has provided accuracy criteria. Lastly, the flechette firing range program provided a correlation between theory and experiment which clearly suggests that high accuracy and low dispersion in flechettes is possible when optimum aerodynamic design is coupled with good saboting and minimization of blast.

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INTRODUCTION

The backbone of ballistics has been the spin stabilized projectile. Virtually, all ordnance from small arms to artillery has almost exclusively utilized the spin stabilized projectile over the last century. Its predecessor was the cannonball and spherical shot. Just as the elongated spin stabilized projectile yielded a marked improvement over the less efficient cannonball, so also fin stabilized ammunition offers great aeroballistic improvements over the spin stabilized projectile. It has only been in recent years that the fin stabilized projectile has come under serious consideration. Some success was achieved by the Germans during World War II with Naval projectile artillery. During the Korean War fin stabilized anti-tank ammunition was introduced which improved the effectiveness of the shape change because of its low spin. In recent years the accuracy of fin stabilized projectiles has improved due to the application of the Tricyclic Theory, the use of dynamic supersonic wind tunnel tests, and improved launching techniques. Because of their small size and the desire for very inexpensive manufacture, the flechette has not received the careful attention that it requires to achieve high accuracy. It is essential that manufacturing techniques, saboting techniques, launching techniques, blast suppression techniques, optimized aeroballistic design procedures, dynamic wind tunnel tests, accuracy theory studies, computer analysis, and precision firings all be undertaken and optimized to achieve good flechette accuracy and low dispersion.

The purpose of this study is to explore flechette design and performance with a view towards achieving high accuracy and low dispersion. Specifically, exploratory firing programs were carried out by Frankford Arsenal, by the Ballistics Laboratories and by the University of Notre Dame. The results of the Notre Dame Flechette Firing Program are summarized in Appendix A.

A dynamic wind tunnel testing program was also carried out by the university on various flechette designs so as to determine the essential static and dynamic aeroballistic stability coefficients. The results of this dynamic wind tunnel program are summarized in Appendix B.

Of particular importance is the development of a computer theory for flechette flight performance, accuracy and dispersion. This theory together with an extensive computer analysis is given in Appendix C. Finally, flechette firings were carried out in the precision range at Frankford Arsenal and a correlation of theory and experiment is also provided in Appendix C. along with a physical evaluation of dispersion.

Based on the theory, sabot design and launcher changes were made in order to reduce the values of those parameters which affect dispersion. A second series of firings were conducted and the analysis of the results is provided in Appendix D.

DISCUSSION

Exploratory Flechette Firing Program

The exploratory flechette firing program both at Frankford Arsenal and at the university have provided an opportunity to measure flechette spin, to measure flechette accuracy and dispersion, to identify fin damage and body damage due to stripper, to provide an approximate measure of dynamic stability at long range, to provide a first hand appreciation of the strong blast region and to concentrate on sabot design, separation, and transition all as affecting flechette flight performance and accuracy.

In addition a transition ballistic range was set up and optimized at Frankford Arsenal to obtain initial condition data using flash x-ray photography. A complete description of the set-up is provided in Appendix C.

BRL conducted free flight tests in their transonic Spark Range to obtain aerodynamic data on the various flechettes under consideration. These data were used in the preliminary development of the dispersion theory and are compared with the wind tunnel results in Appendix B.

Dynamic Supersonic Wind Tunnel Tests of
Four Flechette Configurations

In order to obtain both static and dynamic wind tunnel data on flechette configurations, special tests were carried out at the University of Notre Dame which utilizes its unique vertical down flow supersonic wind tunnel and utilizes its one-degree-of-freedom pitching dynamic support instrumentation. Four flechette configurations were constructed and tested. The data from these dynamic tests was measured on a photo-comparator and reduced and fitted by using the Wobble program. The Notre Dame data on CM_{α} and $C_{M_q} + C_{M_{\dot{\alpha}}}$ is in good agreement with the data obtained by the Ballistic Research Laboratory at small angles of attack and small mach numbers. At the larger angles of attack, the Notre Dame data is as much as four times larger as the BRL data in damping and as much as two times larger than the $C_{M_{\alpha}}$ data. Thus, the nonlinearities which have been uncovered in the dynamic wind tunnel tests are of considerable importance in evaluating flechette flight performance and in evaluating flechette accuracy and dispersion. No wind tunnel data was obtained on the important Magnus moment. This omission is considered extremely serious and it is recommended that future studies be carried out in this area. It is also recommended that the aerodynamic characteristics of the different flechette designs be evaluated with a view towards improvement in performance and accuracy.

Preliminary tests were carried out in obtaining the rolling motion of flechettes at the various angles of attack and in obtaining three-degrees-of-freedom wind tunnel tests where models were able to freely pitch, yaw, and roll. The exploratory rolling tests were carried out in the supersonic wind tunnel at Picatinny Arsenal. Good success was obtained on the basic configuration at small angles of attack. At the large angles of attack the sting support mechanism bent and thus had to be redesigned. These rolling tests have demonstrated that it will be quite possible to obtain excellent free rolling motion performance of flechettes at small and large angles of attack using instrumentation at Picatinny Arsenal.

Three-degree-of-freedom dynamic wind tunnel tests were explored in a preliminary way in the Notre Dame vertical down supersonic wind tunnel. In these tests the model was able to freely pitch and yaw and the afterbody with fins was able to roll freely. The forebody however did not roll The tests were of marginal success but suggested that complete success could be achieved with more effort. It is specifically suggested that the new 3-D testing procedures originally explored at Notre Dame be continued in the Picatinny Arsenal and/or the BRL wind tunnels.

It should be emphasized that the nonlinear aeroballistic dynamic stability coefficients obtained in the Notre Dame program represent a major finding which was extensively utilized in the performance analysis and accuracy computations. It is considered essential that all future flechette designs undergo complete dynamic wind tunnel testing and range firings in order to permit accurate computations of the true dynamic flight performance, accuracy and dispersion of flechettes.

Dispersion Theory of High Fineness Ratio, Cruciform Fin Bodies

A complete jump and dispersion theory is setforth for the free flight performance of flechettes. The six-degree-of-freedom equations of motion are coded for various computer computations which indicated that the flechette accuracy theory accurately predicts the jump and dispersion of flechettes.

In order to determine realistic values for the initial conditions of flight and for the actual dispersion of flechettes, test firings are carried out in order to obtain special experimental data. The raw experimental data is fitted by the least squares method and thereby placed into the form of initial flight conditions. These initial conditions are then applied to the theory. Six-degree-of-freedom numerical computations are used to evaluate the dispersion of eight test rounds. The good agreement between the theory and test firing results indicate that the methods of data analysis and the flechette accuracy theory together provide a precise means of predicting the dispersion of flechettes.

The analysis of the firing data indicates that the large initial conditions of flechette flight result from a strong impulse imparted to the flechette in the muzzle blast regime. It is found that if the transverse impulse imparted to the flechette is equal to an opposite angular impulse then the dispersion will be zero. Since these two impulses rarely balance and always exist, flechette dispersion is generally large. However, by controlling sabot design and muzzle blast, the transverse and angular momentums can be reduced and partially balanced thereby yielding excellent accuracy and low dispersion.

Of particular importance is the invalidation of the classical maximum yaw theory long used in exterior ballistics.

More specifically the complete jump and dispersion theory for flechettes has been reduced to three governing equations which represent flechettes having high, low and very low roll rates. These three theories were found to be accurate by evaluation against six-degree-of-freedom, numerical computations of the equations of motion. It was found therefore that they accurately predict the jump and dispersion of flechettes.

The computer program undertaken to evaluate the flechette accuracy theory includes 201 special case runs carried out in four parts. The first part validates the theory with respect to the aerodynamic restoring and damping moments. The effect of these moments on dispersion was found to depend on the initial conditions.

The second part validated the theory with respect to the aerodynamic Magnus force and moment. The effects on dispersion were found to be very small and of no consequence unless the total dispersion of a particular round was of the same order of magnitude as a Magnus effect.

The third part validated the theory with respect to aerodynamic asymmetries (mass asymmetry, inertia asymmetry, etc.) and roll rate. All three theories were found to be validated in this phase and found to be quite accurate. Aerodynamic asymmetries causing a trim of 1° have little effect on the dispersion of fast rolling flechettes. Slower rolling flechettes were found to have in general increasingly large dispersion values as the roll rate decreased. It can be concluded that for flights which are prone to aerodynamic asymmetry and fin damage, a high roll rate is essential to low dispersion and increased accuracy.

The fourth part validates the theory with respect to gravity. The theory indicates a lateral contribution to dispersion from gravity in addition to the vertical contribution. However, for the flechette this lateral contribution was found to be minimum.

In general, the agreement between the flechette accuracy theory and the computer computations were excellent and account for the effect of the initial launching conditions as well as the static and dynamic stability coefficients and asymmetries. Further, simple equations are given in order to achieve the desired accuracy and optimization.

SUMMARY

By an exploratory firing program, by a supersonic dynamic wind tunnel testing program, by the development of an accuracy theory for jump and dispersion, by computer computations and analysis, and by precision range firings at Frankford Arsenal, flechette accuracy and dispersion is explained, evaluated and improved.

The firing program revealed the importance of fin and body damage, the blast region and saboting. The dynamic wind tunnel program yielded values for the important static and dynamic stability coefficients. The flechette accuracy theory was confirmed by numerical integration of the 6-D equations on the high speed computer where the effects of initial conditions, stability coefficients and asymmetries was revealed and evaluated. Finally, by a flechette firing program in the new Frankford Arsenal Ballistics Range, excellent correlation between theory and experiment for flechette accuracy was obtained.

APPENDIX A

EXPLORATORY FLECHETTE FIRING PROGRAM

Two flechette firing programs were carried out at the University of Notre Dame. The first program was carried out in the Army Firing Range located under the football stands in the Rockne Stadium. In these first firing tests the actual flechette and its sabot were fired at full hypersonic velocity using a mann barrel with sabot stripper. The firings were carried out with the assistance of technical personnel from Frankford Arsenal and under the direct supervision of Army ROTC personnel stationed on the campus and responsible for the Firing Range. These firings revealed two very important discoveries. By firing through light drawing paper yaw cards and by examining the impression left by the passage of the flechette, it was possible to obtain a positive confirmation that the fins were being seriously damaged and/or bent by the stripper. This finding was transmitted to the cognizant Frankford Arsenal personnel where suitable corrective changes were initiated and finalized thereby eliminating the problem of fin damage.

The second major finding of the first flechette firing program, insofar as university investigators were concerned, was the recognition of the tremendously intensive and long muzzle blast regime. While a standard 22 projectile is fired in the range with little noise and little blast, the flechette system of basically the same weight but fired at large velocity yields a tremendous concussion and a tongue of fire, blast and flame stretching some 3-4 feet. The importance of the recognition of the strong blast region lies in its effect in disturbing the flechette at launch and thereby contributing to inaccuracy.

The first firing program therefore revealed fin damage due to sabot strippers and a large blast region which contributed to jump and inaccuracy.

The second flechette firing program carried out at the university utilized an air gun in simple subsonic launchings. The range setup is shown in Figure 1. The purpose of this special firing setup was to explore various saboting techniques. In this program sabots of both pusher design and puller designs were investigated. Also body inset sabot designs were studied, see Figure 2. Representative target data is illustrated in Figure 3 where effects of sabot designs are clearly evident. Various flechette and sabot designs are shown in Figures 4 and 5.

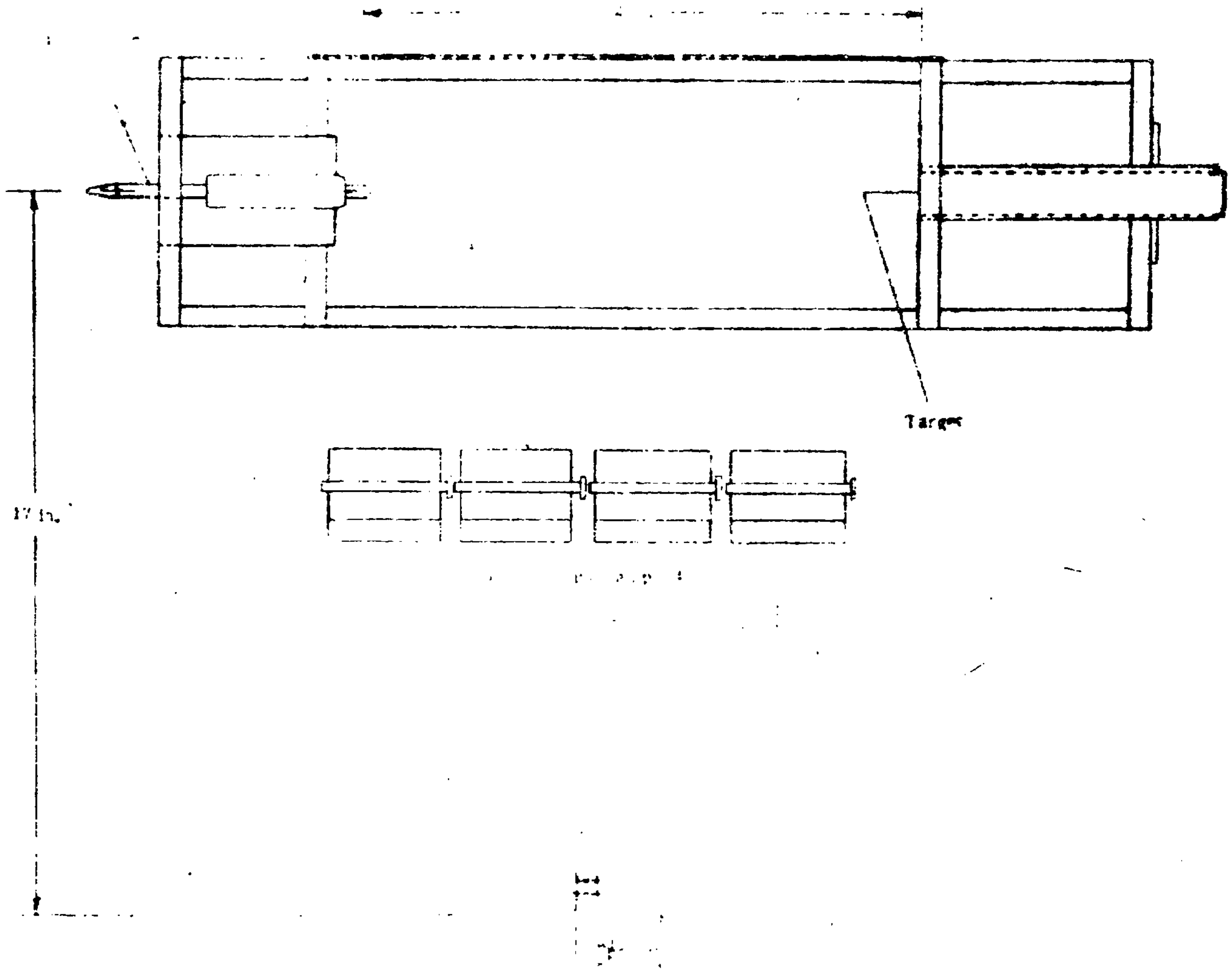


Figure 1. Subsonic Firing Range

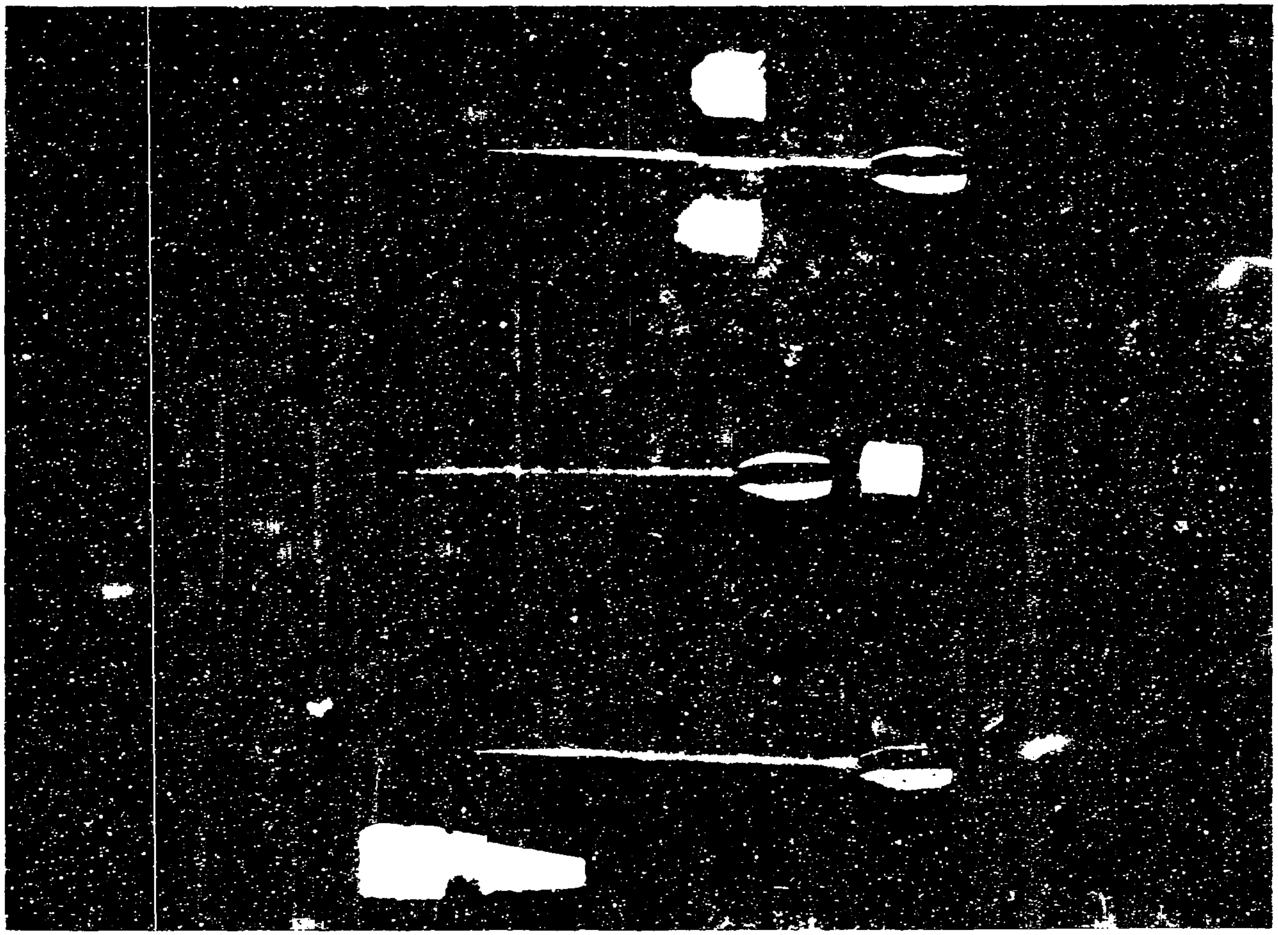


Figure 2. Flechette Sabot Designs

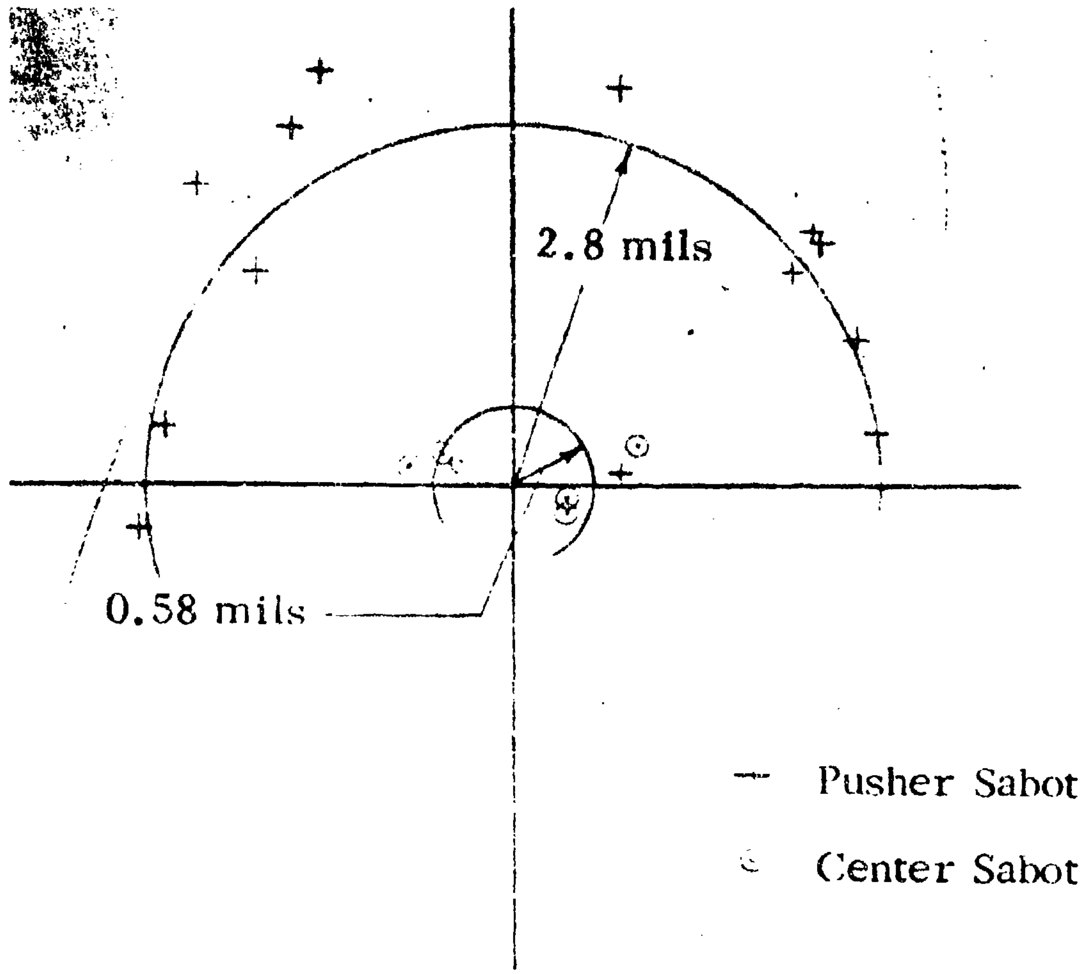


Figure 3. Comparison of Pusher and Center Sabot Results Flechette Testing

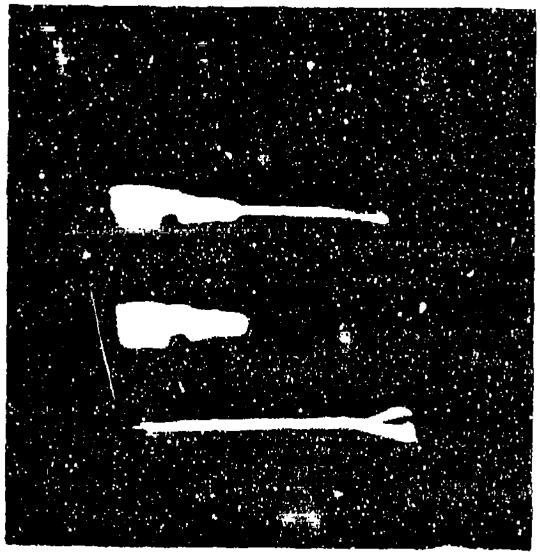
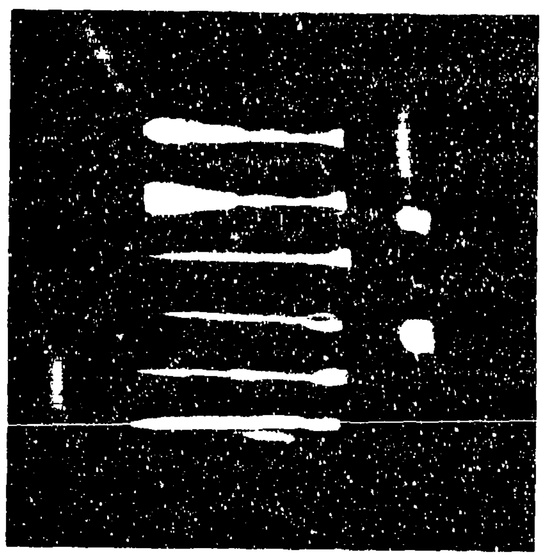


Figure 4. Producibility Sabot - R & D Flechette



5. Various Puller and Pusher Sabots and Flechette Configurations

APPENDIX B

DYNAMIC SUPERSONIC WIND TUNNEL TESTS OF FOUR-FLECHETTE CONFIGURATIONS

DYNAMIC SUPERSONIC WIND TUNNEL TESTING*

ABSTRACT

The linear values of the static pitching moment stability coefficient, C_{M_α}, and the damping moment stability coefficient, $C_{M_q}+C_{M_{\dot{\alpha}}}$, are determined versus angle of attack for four flechette designs. The program is carried out in a vertical supersonic wind tunnel using a one-degree-of-freedom dynamic testing technique. This method allows the model to go through free one-degree-of-freedom angular oscillations. Stability parameters are extracted from a film record of this motion and the stability coefficients are computed using the WOBBLE computer program. Good repeatability of the results is shown for low angle of attack.

*Prepared by Michael Garsik.

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LIST OF SYMBOLS

a Local speed of sound (feet/second)

a_T Total speed of sound (feet/second)

C_{M_α} Static pitching moment stability coefficient (rad^{-1})

$$C_{M_\alpha} = \frac{M_\alpha \alpha}{\alpha\, QSd}$$

C_{M_q} Damping moment stability coefficient (rad^{-1})

$$C_{M_q} = \frac{M_q q}{QSd \ \frac{qd}{2V}}$$

$C_{M_{\dot\alpha}}$ Damping moment stability coefficient due to aerodynamic lag (rad^{-1})

$$C_{M_{\dot\alpha}} = \frac{M_{\dot\alpha}\ \dot\alpha}{QSd \ \frac{\dot\alpha d}{2V}}$$

$C_{M_{\delta_\epsilon}}$ Aerodynamic asymmetry moment stability coefficient (rad^{-1})

$$C_{M_{\delta_\epsilon}} = \frac{M_{\delta_\epsilon} \delta_\epsilon}{\delta_\epsilon\ QSd}$$

d Reference length, missile diameter (ft.)

$I = I_y = I_z$ Pitching moment of inertia (slugs/feet^2)

$K_{1,2}$ Amplitude of nutation and precession arms (rad)

K_3 Trim mode (rad)

L, M, N Moments about X, Y, Z aeroballistic axes (ft-lb)

M_α Pitching moment derivatives (ft-lbs/rad)

$M_{\dot\alpha}$ Damping moment derivative due to aerodynamic lag (ft-lbs sec/rad)

M_q	Damping moment derivative (ft-lbs sec/rad^2)
M_{δ_ϵ}	Asymmetry moment derivative (ft-lbs/rad)
p, q, r	Angular rates about aeroballistic axes (rad/sec
Q	Dynamic pressure $Q = \frac{1}{2}\rho U^2$ (lb/ft^2)
R	Gas constant
S	Reference area, $S = \frac{\pi d^2}{4}$ (ft^2)
t	Time (sec)
T_t	Total temperature ^{o}R
U	Total velocity (ft/sec)
X, Y, Z	Aeroballistic axes
x, y, z	Space-fixed axes
α	Angle of attack (rad)
β	Angle of sideslip (rad)
θ, ψ, ϕ	Euler angles (rad or deg)
ρ	Air density (slugs/ft^3)
$\lambda_{1,2}$	Damping rate (rad/sec)
$\omega_{1,2}$	Nutation and precession frequency (rad/sec)
γ	Ratio of specific heats, $\frac{c_p}{c_v}$
δ	Phase angle (rad)

INTRODUCTION

With the advent of more advanced analysis techniques[1] today's aerodynamicist has the power to achieve a better understanding of the free flight performance of a flight vehicle. Data such as angular motion, jump angle and dispersion can now be extracted from free flight data and studied[2] so that previously undetected instabilities and design failures can be corrected. Obviously from this there arises a clear need for development of free flight simulations.[3,4] The random method used in trying to solve the problems of stability and flight performance would prove dangerous and costly if full scale flight tests were conducted. It would be much cheaper and safer to experiment with new designs on models of the actual configuration. This presents the problems of simulating free flight motions so that data can be extracted and the new designs evaluated just as if the test were conducted on a full scale model in free flight.

Ballistic range firings was one of the initial attempts at a flight simulation technique. It involved taking photographs at various stations along a firing range of a model that had been launched from a gun. Because of the limitations on the types of motion that could be observed, the lack of control of initial conditions, and other limiting factors, it soon became apparent that a more sophisticated method of simulation was necessary. Attention was turned to the wind tunnel.

Attempts to study the angular motions of flight vehicles in the wind tunnel began by mechanically reproducing them. This technique ran into several problems, in particular separating the driving mechanism response from the aerodynamic response and the fact that the technique is limited in that a mechanical response, rather then a free one, to the flow field is used. In recent years the most successful wind tunnel simulation technique, dynamic wind tunnel testing, has been developed. Actually there are several types of dynamic wind tunnel testing. The free flight angular oscillation method exhibits complete six-degree-of-freedom motion and needs no external support system, however certain limitations to this technique do exists. The duration of the simulation is restrictive hence length of the "flight" is very short. Also, a lack of control of initial conditions prohibits the study of particular flight modes. Another method, that of constrained angular oscillations, eliminates these disadvantages at the expense of introducing new ones. The most predominate disadvantage is the interference effects of the support system on the response of the model to the flow field. This assumes that the problem of building an adequate support system can be solved. It is important to have control over the initial conditions and the length of the simulation run in order to simulate the free flight angular motions in the wind tunnel. Of course, the choice of which method to use depends on the careful consideration of the problem at hand and the experimental limitations which could be allowed and not interfere with the test being carried out.

With regard to the constrained angular oscillation technique and its use in the superso ic wind tunnel, several methods have been developed. The gas bearing system is one that is ideally suited to the study of low fineness ratio, non-finned bodies such as projectiles. It does not lend itself to the study of high fineness ratio finned bodies quite as well. One of the drawbacks of this technique is the high cost of construction and maintenance of the system. The jewel bearing support system has been utilized in supersonic wind tunnel testing to observe the rolling motion of various models of flight vehicles. Such a system has been successfully employed in determining the roll damping moment and induced roll moment stability coefficients for different flight configurations.

This investigation is intended to determine the linear pitching moment and damping moment stability coefficients of four flechette configurations in a supersonic regime. The study was conducted under a contract awarded to the Department of Aerospace and Mechanical Engineering at the University of Notre Dame by Frankford Arsenal, Philadelphia, Pa. The contract deals with a study of the jump angle and dispersion of the flechette configurations. An underlying intent will be to document the constrained angular oscillation technique used in the supersonic wind tunnel tests.

In order to study the performance of the flechette configurations and to be able to predict their flight path, a basic understanding of the stability of the rounds must be obtained. Adequate stability prediction requires that techniques of flight simulation be used which will produce continuous results for supersonic conditions.

The actual steps taken in developing such a program of dynamic wind tunnel tests were: 1) adapting the one-degree-of-freedom free oscillation technique to the supersonic wind tunnel; 2) recording the one degree of freedom angular oscillations of the models in the supersonic wind tunnel by high speed photography techniques; 3) reducing the motion of the models to numerical values of angle of attack; 4) fitting the Aero-ballistic Theory to the angular data obtained to determine the stability parameters $K_{N,P}$, $\lambda_{N,P}$, $\omega_{N,P}$;[5,6] 5) computing the aerodynamic stability coefficients from Linear Theory using the stability parameters, model parameters, wind tunnel Mach number and density; 6) analyzing the interference of the support system by checking the repeatability of results.

To accomplish the goals set down a unique method of supporting the pure pitch flechette models are utilized.[7] It involved suspending the model in the test section of the University of Notre Dame's vertical supersonic wind tunnel and allowing it to go through free one-degree-of-freedom oscillations. The low friction in the system allowed continuous motions to be obtained and recorded and the stability coefficients to be extracted from the angular data.

AEROBALLISTIC THEORY

Axis Systems

Two basic axis systems are used. The space fixed axis system (Figure 1) is the system in which the data is recorded. The aeroballistic axis system (Figure 2) is the system in which the equations of motion are expressed. By choosing the x-axis of the space fixed system to coincide with the velocity vector the data is made directly compatible to the equations of motion. From Figures 1 and 2 it is seen that $\theta = \alpha$ and $q = \dot{\theta}$. Care must be taken in extending this comparison beyond this point.

The linear theory for a missile constrained at its center of gravity for one-degree-of-freedom pure pitching is as follows.

Linear Theory

In the development of the Linear Theory several assumptions are made:

1. Aerodynamic coefficients are constant
2. Velocity and density are constant
3. All angular motions except roll are small enough that the small angle approximations may be used:

$$\sin x = \tan x = x$$

$$\cos x = 1$$

4. The missile has mirror symmetry and trigonal or greater rotational symmetry.

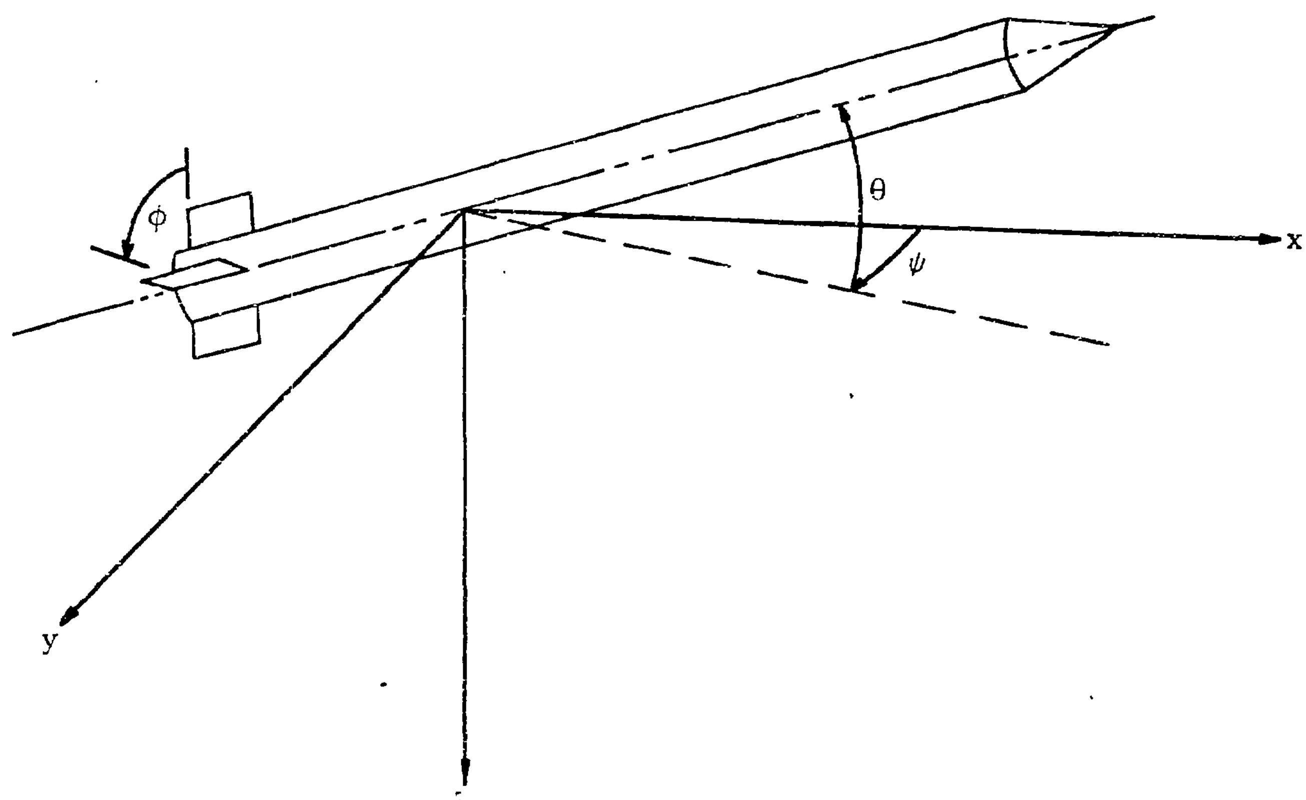


Figure 1. Space Fixed Axis System

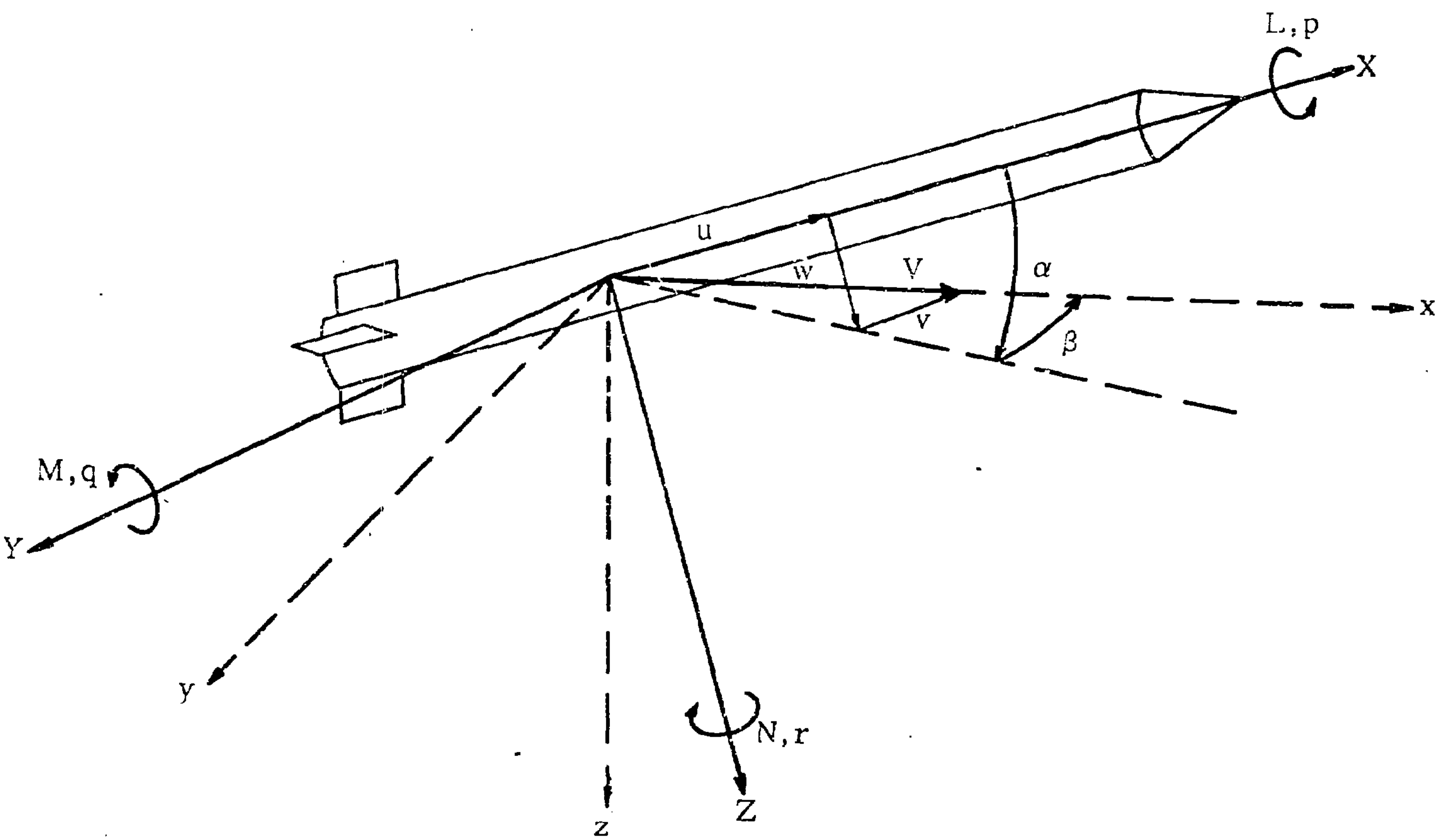


Figure 2. Aeroballistic Axis System

The fundamental differential equation of motion for the rotational motion is

$$M = I\ddot{\theta} \tag{1}$$

The sum of the acting aerodynamic moments, shown in Figure 3, which are assumed to vary linearly with angle of attack is

$$M = M_{\alpha}\alpha + M_{q}q + M_{\dot{\alpha}}\dot{\alpha} + M_{\delta_{\epsilon}}\delta_{\epsilon} \tag{2}$$

where

$$\begin{aligned}
M_{\alpha} &= C_{M_{\alpha}} \frac{1}{2} \rho U^2 Sd \\
M_{q} &= C_{M_{q}} \left[\frac{d}{2u}\right] \frac{1}{2} \rho U^2 Sd \\
M_{\dot{\alpha}} &= C_{M_{\dot{\alpha}}} \left[\frac{d}{2u}\right] \frac{1}{2} \rho U^2 Sd \\
M_{\delta_{\epsilon}} &= C_{M_{\delta_{\epsilon}}} \frac{1}{2} \rho U^2 Sd
\end{aligned} \tag{3}$$

Because of the selection of the particular axis systems and their orientation, Equation 1 can be rewritten as

$$M = I\ddot{\alpha} \tag{4}$$

Equation 2 can be rewritten as

$$M = M_{\alpha}\alpha + M_{q} + M_{\dot{\alpha}} \quad \dot{\alpha} + M_{\delta_{\epsilon}}\delta_{\epsilon} \tag{5}$$

Combining Equations 4 and 5 and rearranging

$$\ddot{\alpha} - \left[\frac{M_{q} + M_{\ddot{\alpha}}}{I}\right] \dot{\alpha} - \left[\frac{M_{\alpha}}{I}\right] \alpha = M_{\delta_{\epsilon}}\delta_{\epsilon} \tag{6}$$

and

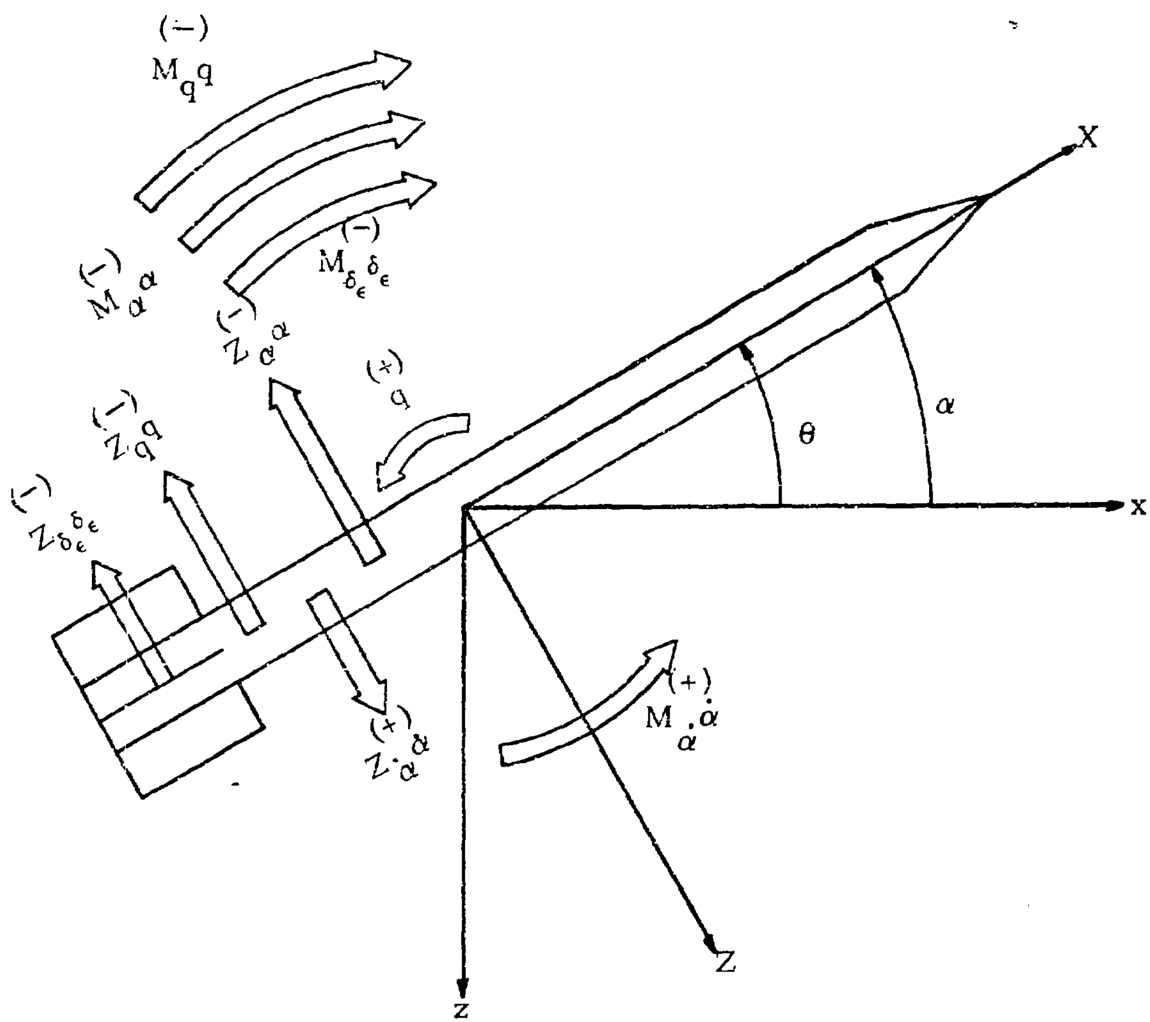


Figure 3. Static and Dynamic Fluid Forces

$$\ddot{\alpha} + N_1\dot{\alpha} + N_2\alpha = N_3 \tag{7}$$

where

$$N_1 = -\left[\frac{M_q + M_{\dot{\alpha}}}{I}\right]$$

$$N_2 = -\left[\frac{M_\alpha}{I}\right] \tag{8}$$

$$N_3 = \left[\frac{M_{\delta_\epsilon}\delta_\epsilon}{I}\right]$$

Solving for the homogeneous solution to Equation 7 assume a solution of the form

$$\alpha = Ke^{\phi t} \tag{9}$$

Differentiation of this yields

$$\dot{\alpha} = \phi Ke^{\phi t} \qquad \ddot{\alpha} = \phi^2 Ke^{\phi t} \tag{10}$$

Substitute Equation 9 and 10 into the homogeneous form of Equation 7

$$\phi^2 Ke^{\phi t} + N_1\phi e^{\phi t} + N_2 e^{\phi t} = 0$$

$$\phi^2 + N_1\phi + N_2 = 0$$

which has a solution of the form

$$\phi_{1,2} = -\frac{N_1}{2} \pm \frac{1}{2}\sqrt{N_1^2 - 4N_2} \tag{11}$$

For missiles in air the assumption that the products of stability derivatives are negligible when compared to themselves (i.e. $N_1^2 << N_2$)

can be made. This is generally a good assumption and will be made here. Hence Equation 11 can be written

$$\phi_{1,2} = -\frac{N_1}{2} \pm i\sqrt{N_2}$$

$$= \lambda_{1,2} + i\,\omega_{1,2} \tag{12}$$

The homogeneous solution has the form

$$\alpha = K_1 e^{(\lambda_1 + i\omega_1)t} + K_2 e^{(\lambda_2 - i\omega_2)t} \tag{13}$$

where

$$\lambda_1 = \lambda_2 = \left[\frac{d}{2u}\right] \frac{1}{2} \rho U^2 S d \; \frac{C_{M_q} + C_{M_{\dot{\alpha}}}}{2I} \tag{14}$$

$$\omega_1 \approx \left[\frac{C_{M_\alpha} \frac{1}{2} \rho U^2 Sd}{I}\right]^{1/2} \tag{15}$$

$$\omega_2 \approx -\left[\frac{C_{M_\alpha} \frac{1}{2} \rho U^2 Sd}{I}\right]^{1/2} \tag{16}$$

and

$$C_{M_\alpha} \approx -\frac{2 I \omega^2}{\rho U^2 Sd} \tag{17}$$

$$(C_{M_q} + C_{M_{\dot{\alpha}}}) \approx \frac{8 I \lambda}{\rho U Sd} \tag{18}$$

Solving for the particular part of the solution of Equation 7 consider the steady state case of no pitching, Equation 7 would be

$$N_2 \alpha = N_3$$

$$\alpha = \frac{N_3}{N_2} = - \frac{M_{\delta_\epsilon} \delta_\epsilon}{M_\alpha} = K_3 \tag{19}$$

This is the particular part of the solution of Equation 7. The complete solution is

$$\alpha = K_1 e^{(\lambda_1 + i\omega_1)t} + K_2 e^{(\lambda_2 + i\omega_2)t} + K_3 \tag{20}$$

where K_1 and K_2 are found from initial conditions and are

$$K_{1,2} = \frac{\dot{\alpha}_o - \phi_{2,1} \alpha_o}{\phi_{1-2} - \phi_{2,1}} + \frac{\phi_{2,1} K_3}{(\phi_{1,2} - \phi_{2,1})} \tag{21}$$

Since the magnitudes of ϕ_1 and ϕ_2 are always equal and K_3 is constant

$$K_1 = K_2 = K$$

Since

$$e^{i\omega t} = \cos \omega t + i \sin \omega t$$

Equation 19 can be written as

$$\alpha = 2Ke^{\lambda t} \cos \omega t + K_3$$

or in a more general form

$$\alpha = K_o e^{\lambda t} \cos (\omega t + \delta) + K_3 \tag{22}$$

where

$$K_o = 2K$$

Equation 22 is the basic modal which will be used to fit the one-degree-of-freedom data. A physical representation of what Equation 22 means and how it reduces the Tricyclic Theory to a pure pitching motion case is shown in Figure 4. The two arms K_1 and K_2 have been replaced by a single arm of length K where $K=K_1+K_2$. This arm is rotating at a rate $\omega=\omega_1$ and has an initial orientation of $\delta=\delta_1$. The cosine function projects this arm onto the vertical axis of the aeroballistic axis system to give values of θ. This "projection" follows the pure pitching of the model as if it would look when observed from the rear.

Computation of Aerodynamic Stability Coefficients

To fit Equation 22 to the angular oscillation data the WOBBLE computer program was used. This program fits the theory to short segments of the data in overlapping pieces so that the stability parameters λ_1, ω_1 and K_1 are determined as functions of time.

Computation of Linear Coefficients

Using the velocity and model parameters (Appendix A) along with λ_1, ω_1 and K_1 the pitching moment stability coefficient, C_{M_α}, and the damping moment stability coefficient, $(C_{M_q}+C_{M_{\dot{\alpha}}})$, were computed. Equations 17 and 18 were used to compute these coefficients as functions of time.

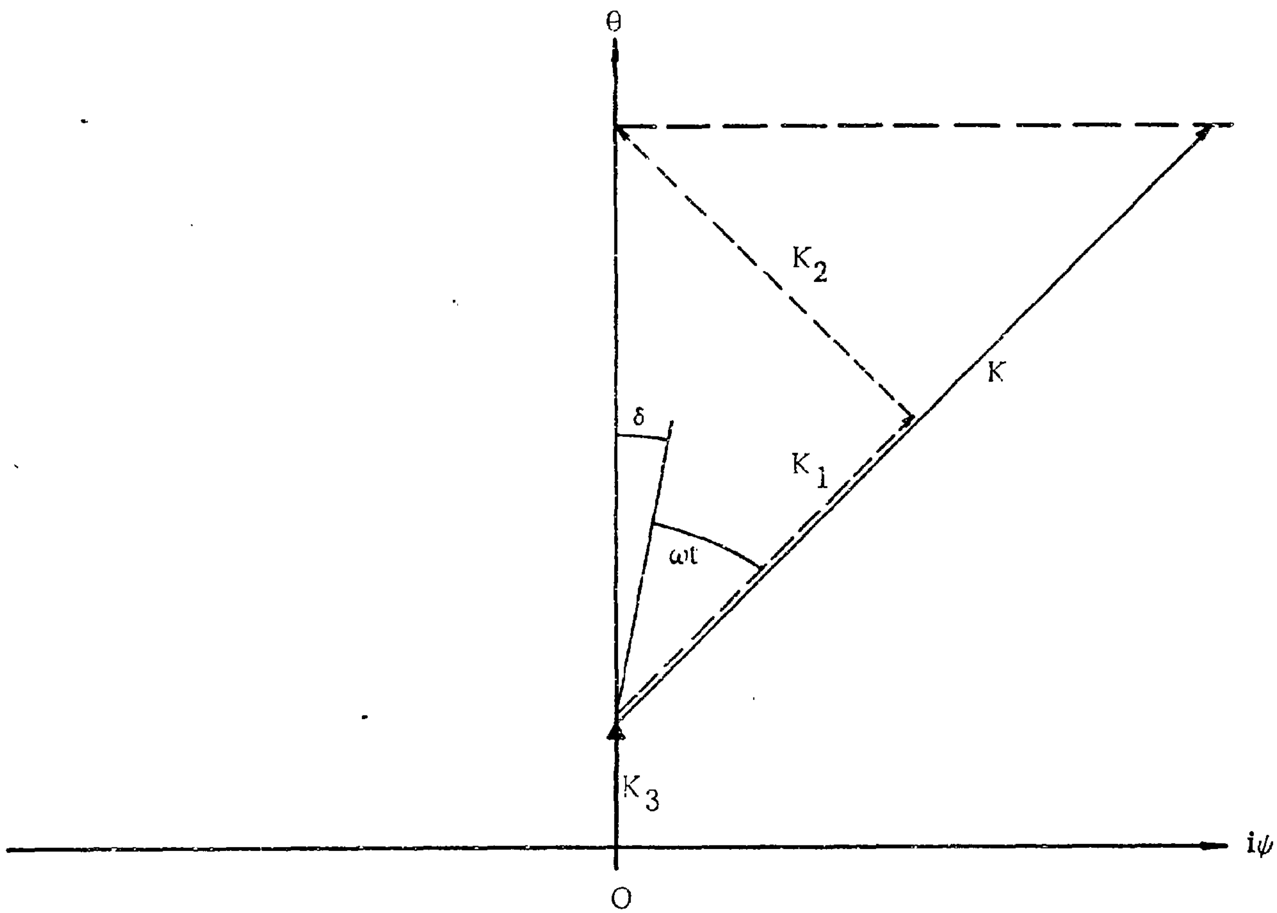


Figure 4. Single-Degree-of-Freedom Motion

Experimental Technique

Four different configurations were tested, the Ground Point, Olin, Swaged Point, and Tracer. Schematic representations of the model configurations are given in Figures 5, 6, 7, and 8 respectively.

One-Degree-of-Freedom Wind Tunnel Test Procedures

All of the tests were carried out in the University of Notre Dame's vertical supersonic wind tunnel shown in Figure 9. This wind tunnel features a vertical test section fitted with interchangeable steel and glass walls. A steel wall was used on one side to give maximum support to the model support system and a glass wall was used on the other side to allow observation of the models. The basic idea behind the support system is shown in Figures 10, 11, 12 and 12a.

To mount the model in the tunnel the following system was used. A length of piano wire 0.030" in diameter was inserted through the hole in the glass wall and into a syringe tube. The purpose of the two syringe tubes, one on each side of the model, was to insure that the model would remain in the center of the wind tunnel test section after it was released and allowed to oscillate. After running the wire through the first syringe tube, it was pushed through a small hole 0.040" in diameter drilled perpendicular to the longitudinal axis at the center of gravity of the model. The wire was then pushed through the second syringe tube and guided out of the test section through a hole in the steel wall. The wire was secured outside the wind tunnel test section by a system shown in Figure 11. On

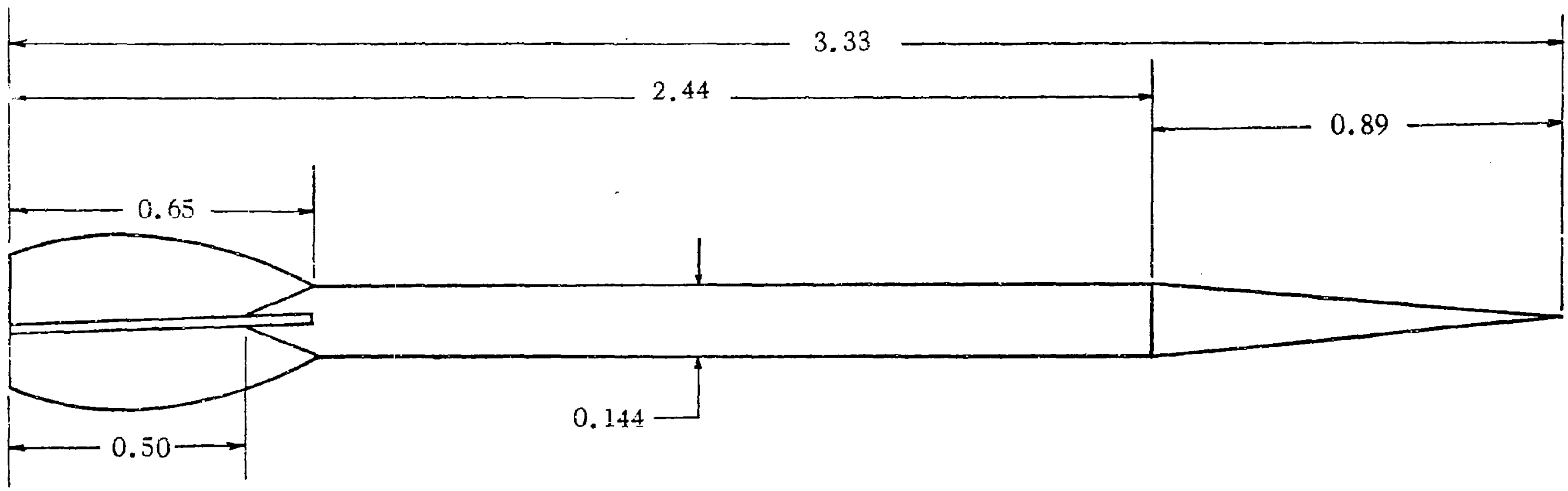


Figure 5. Ground Point Wind Tunnel Model

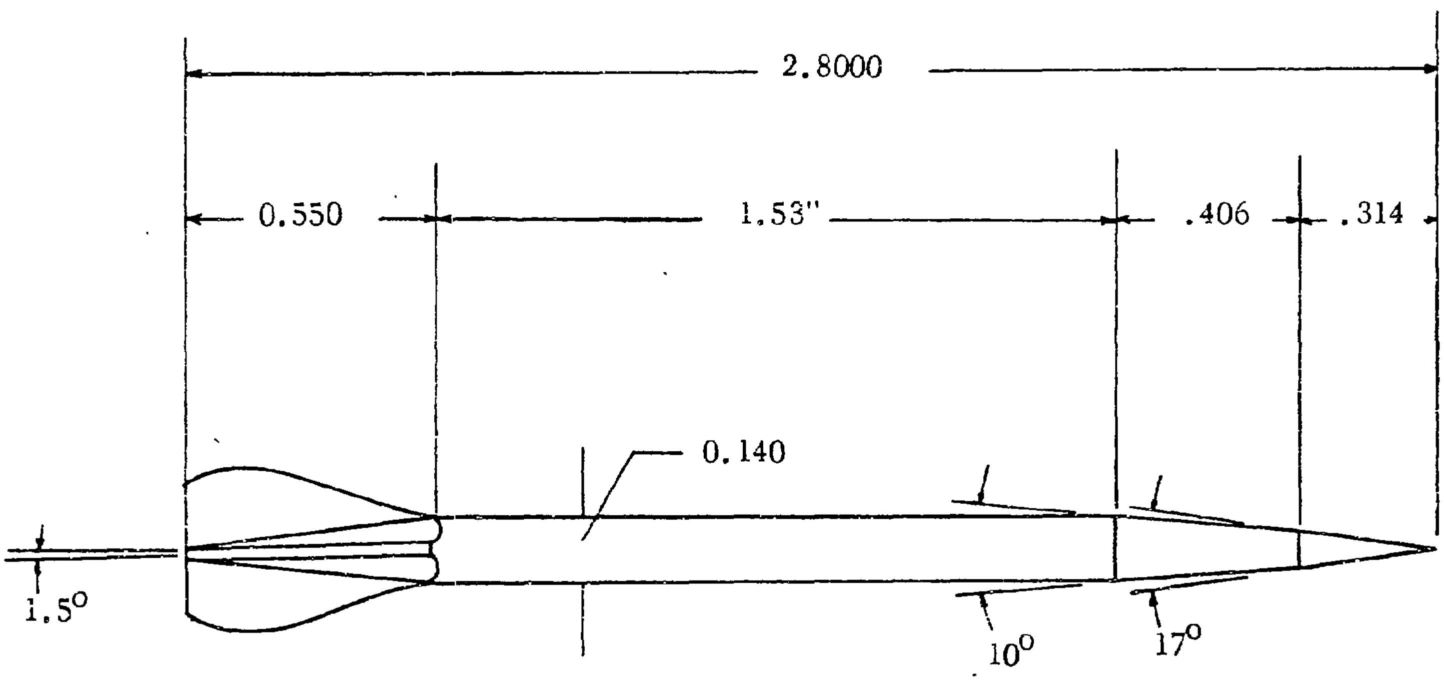


Figure 6. Olin Wind Tunnel Model

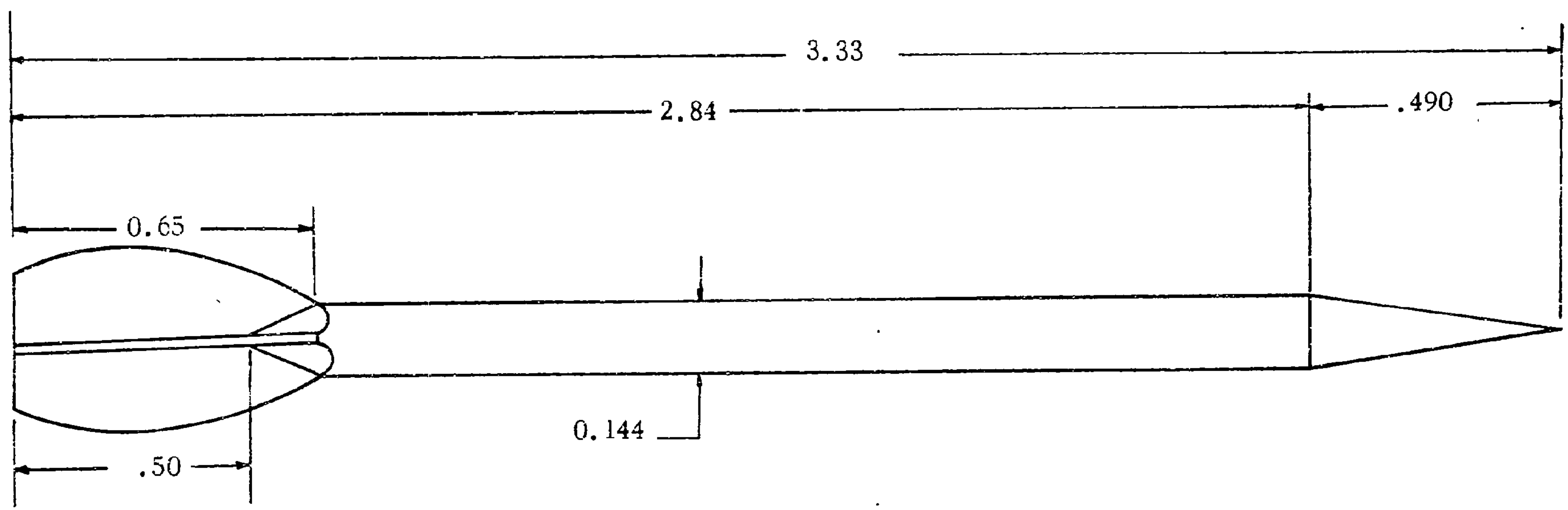


Figure 7. Swaged Point Wind Tunnel Model

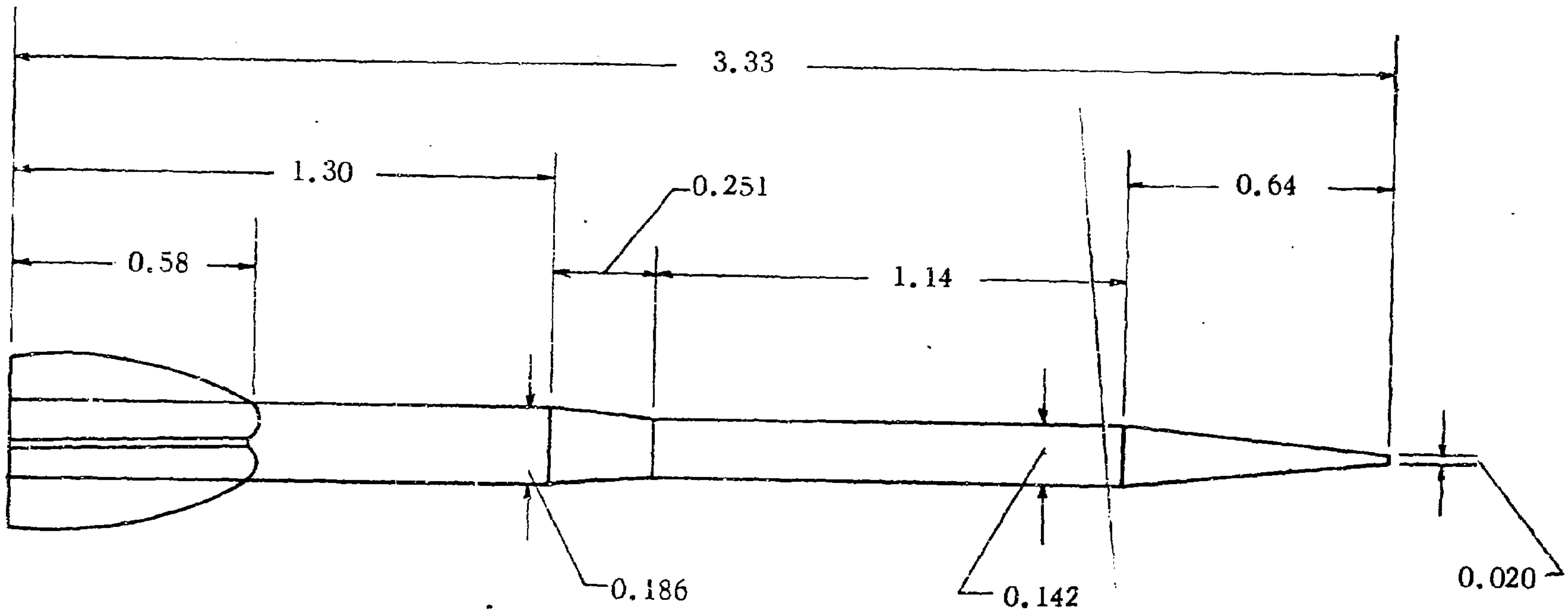


Figure 8. Tracer Wind Tunnel Model

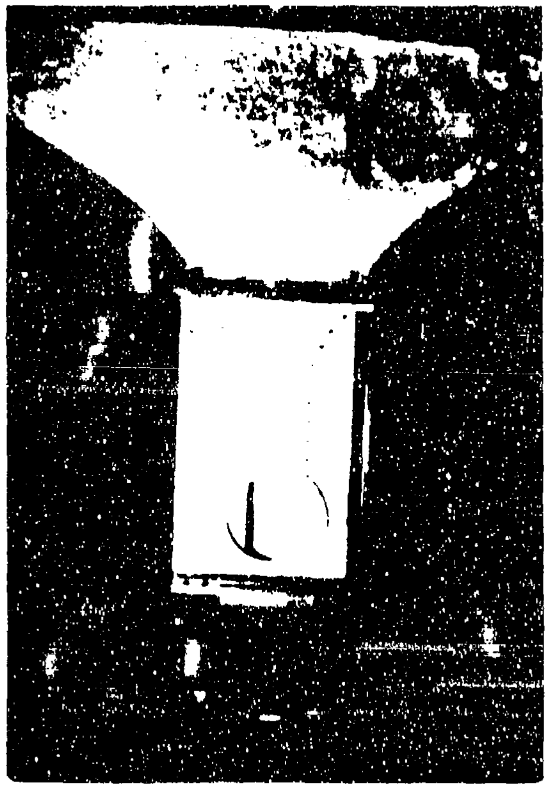


Figure 9. Vertical Supersonic Wind Tunnel

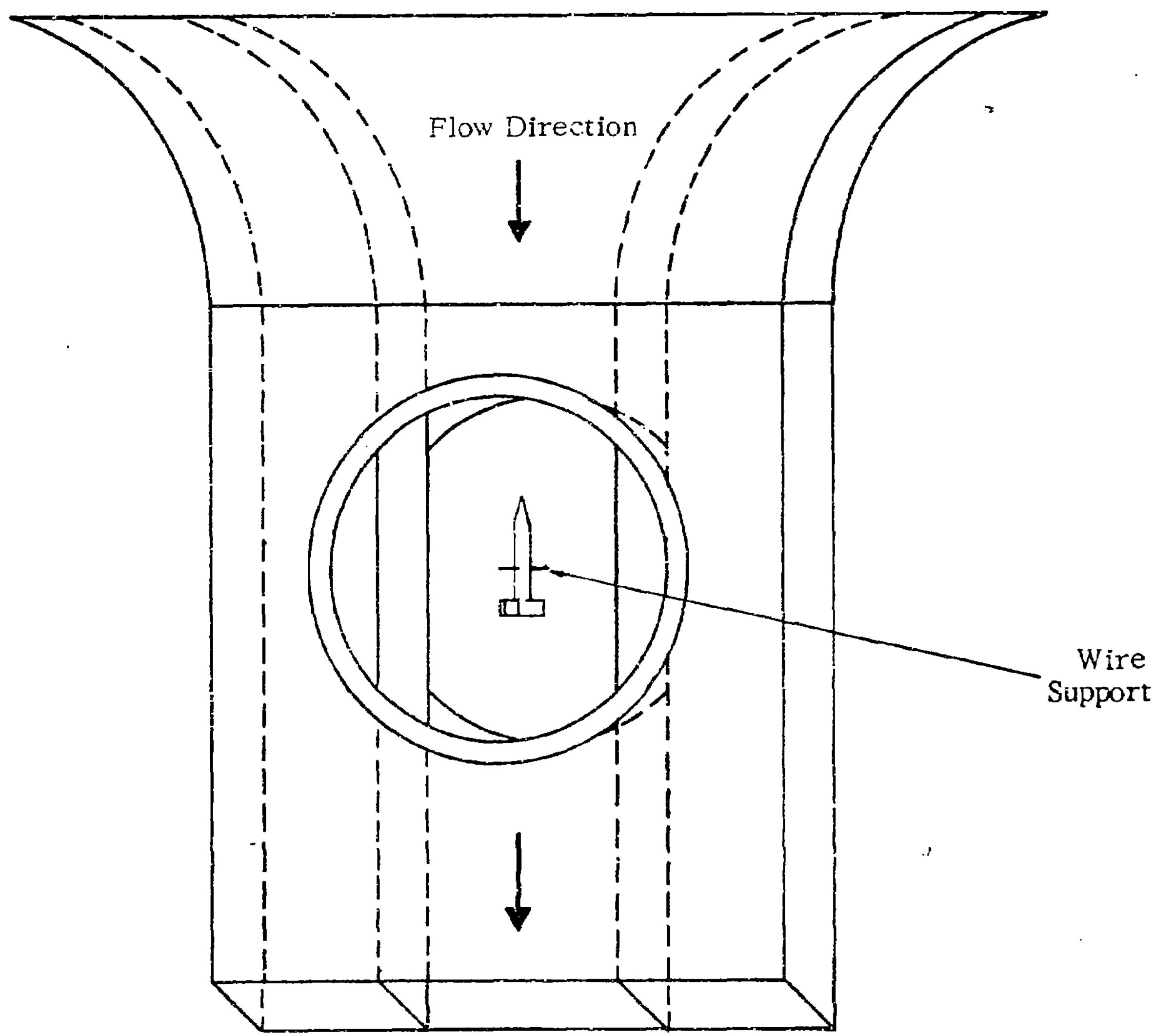


Figure 10. Flechette Mounted in Supersonic Wind Tunnel

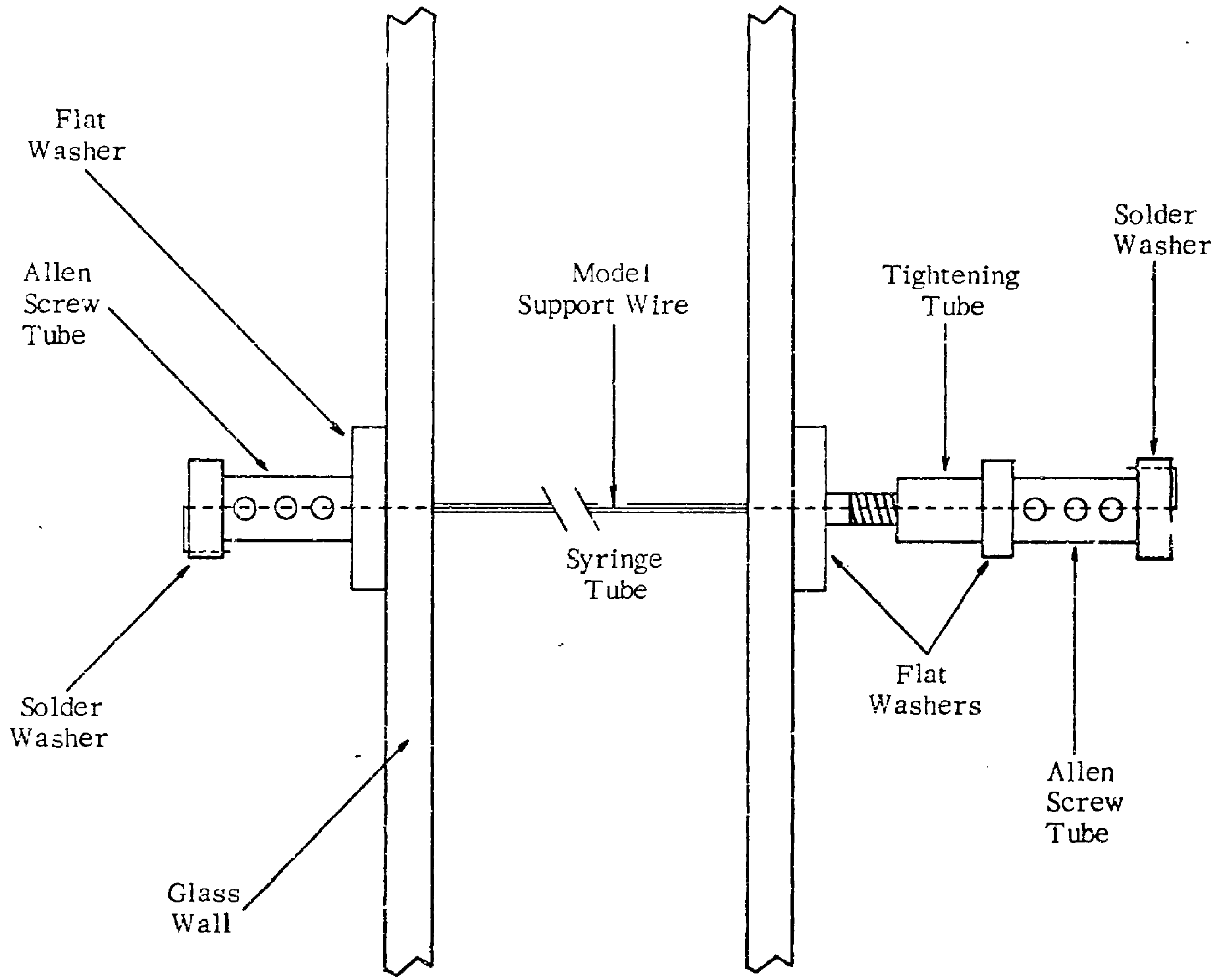


Figure 11. Exterior Support System

Figure 12. Exterior Support System (Exploded View)

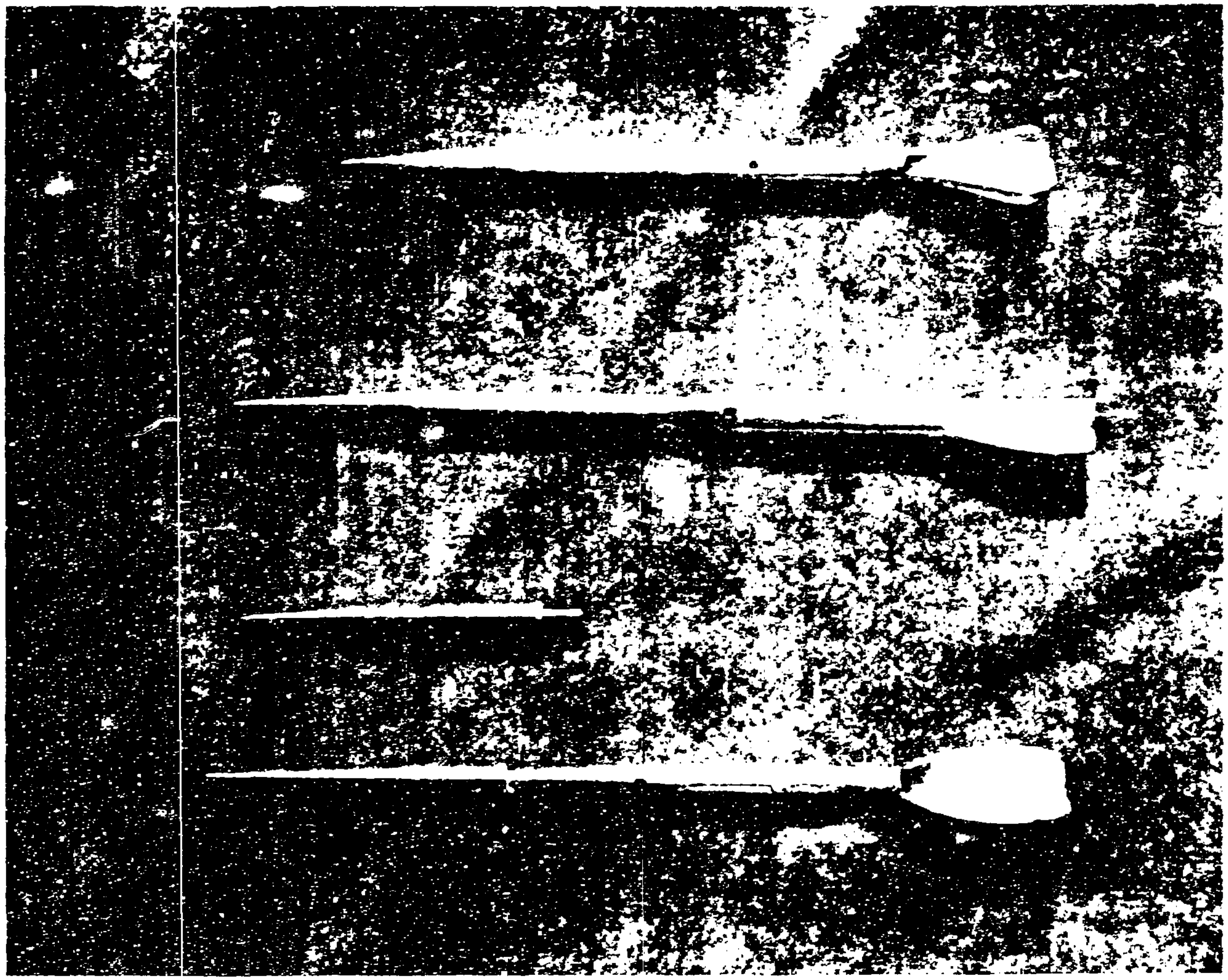


Figure 6. Supersonic Wind Tunnel Models

the glass wall side the wire was put through a hole in a flat washer placed flush against the glass wall. The hole in the washer had a diameter closer in size to the diameter of the wire then the hole in the glass wall. This cut down on the disturbance of the flow caused by the presence of the hole in the wall of the test section. Next, the wire was secured by placing it through an Allen screw tube and a solder washer. An Allen screw tube is a long cylinder with a small diameter hole drilled along its longitudinal axis and three small holes drilled perpendicular to the axis. These holes have been tapped to accommodate Allen screws which can be tightened to clamp down on the piano wire and hold it in place. A solder washer is a short cylinder containing two small diameter holes, one at the center and one near the outer edge. After running the wire through the center hole it can be bent around into the second hole at the outer edge. This hole also has a small hole drilled perpendicular to it and tapped to hold an Allen screw. As in the Allen screw tube, this Allen screw can be tightened down on the support wire to secure it. This system holds the support wire on the glass wall side of the test section.

After running the wire through the steel wall side it was pushed through a flat washer identical to the one on the glass wall side. A tightening tube was placed next in position and the wire was guided through it. A tightening tube is two concentric cylinders which are matched by threading. The length of the tube can be adjusted to the desired size by rotating the outer tube about the inner one. Finally, the piano wire was secured using an Allen screw tube and a soldier washer. This completed the setting up of the support system. One advantage not already mentioned comes to light at this point. The models could be easily removed and inserted into the test section of the wind tunnel.

After the support system was in place the tension in the wire was adjusted by changing the length of the tightening tube. The tension was set so that the model would not change its vertical position after the tunnel was turned on. The model was then rotated 180° and held in place by a retaining mechanism shown in Figure 13. This system consisted of an extendable retainer which was placed around the nose of the model to secure it at its initial angle of attack. The retainer was connected to a release wire which could be manually operated from outside the tunnel. When the release wire was pulled the retainer would slip off the nose of the model and the model would be free to oscillate.

To record the oscillations of the model a Wollensak Fastex high speed motion picture camera was used. The camera was set-up as shown in Figure 14 on the glass wall side of the test section. Two floodlights, one just above the camera position and one above the inlet of the wind tunnel, were used to provide maximum lighting of the model in the test section. The camera was operated at a speed of 3000 frames per second for three seconds with a lens opening of f5.6.

Upon completing all preparations the tunnel was started following the procedure in Appendix B. The retainer was pulled back and the subsequent angular motion of the model was recorded.

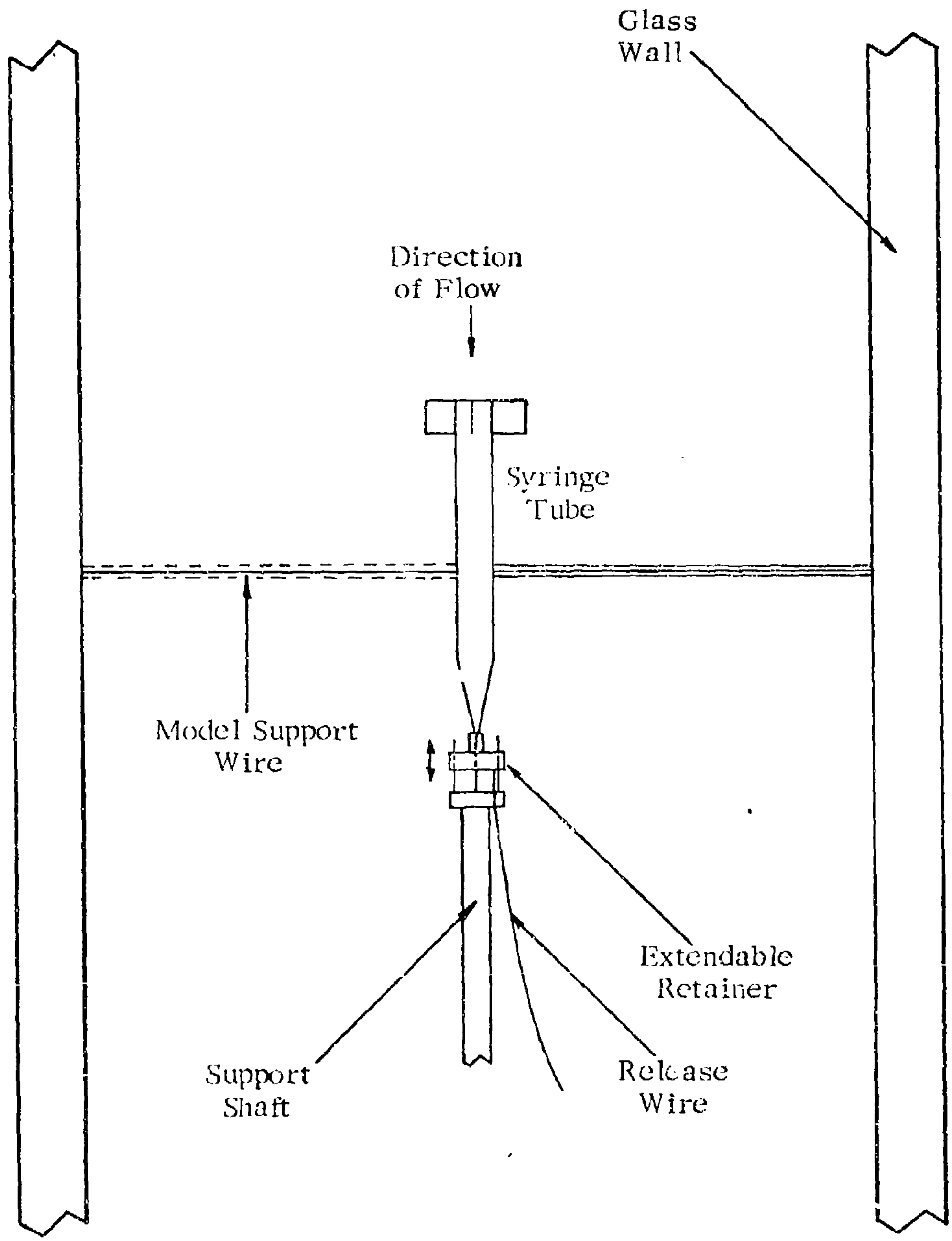


Figure 13. Retaining Mechanism

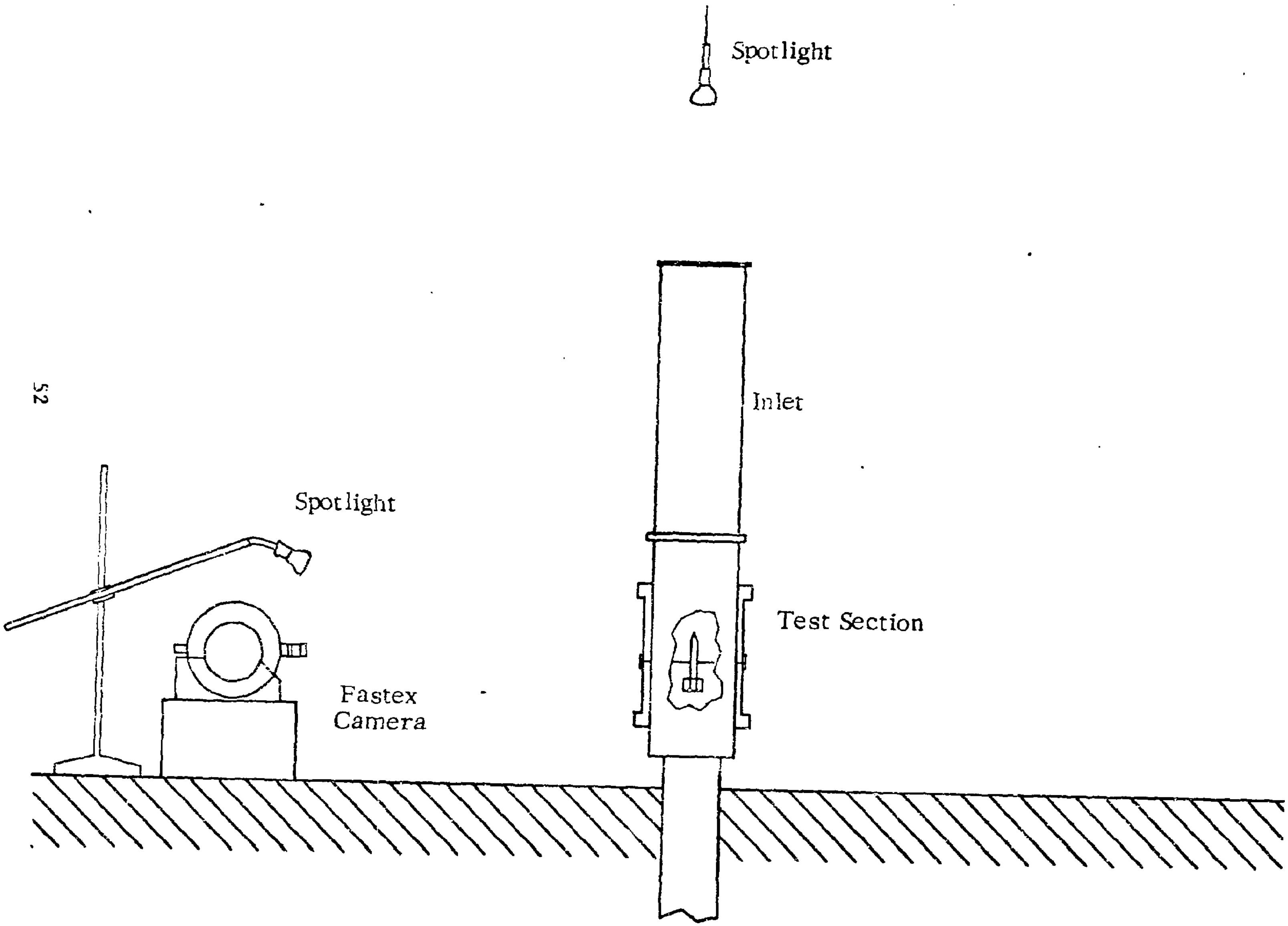


Figure 14. Camera Setup

One-Degree-of-Freedom Data Reduction Procedure

The one-degree-of-freedom oscillations were converted to numerical values of angle of attack in the following manner. Two reference dots at a known distance apart had been placed on the steel wall in the test section behind the model. These dots were included in each frame of the film record of the angular motions of the model. The dots were placed such that a horizontal line running between them was above the highest point that the model with the largest radius would reach. For each configuration the radius of oscillation, the distance from the pivot point to the nose of the model, was also known. The relative coordinates of the reference dots and the nose of the model were determined from the data film using an optical comparator shown in Figure 15. A computer program called REDUCE, presented in Appendix C, using these coordinates and the known conversion distance between the reference dots was then employed to produce a time history of the angular oscillations of the model. A schematic of the reduction coordinates is presented in Figure 16.

Velocity Determination Technique

Since all the tests were not conducted on the same day it was necessary to determine the velocity in the wind tunnel on the particular day the test was conducted. A method of measuring the static pressure in the test section was necessary to do this. A system like the one in Figure 17 was used to do this

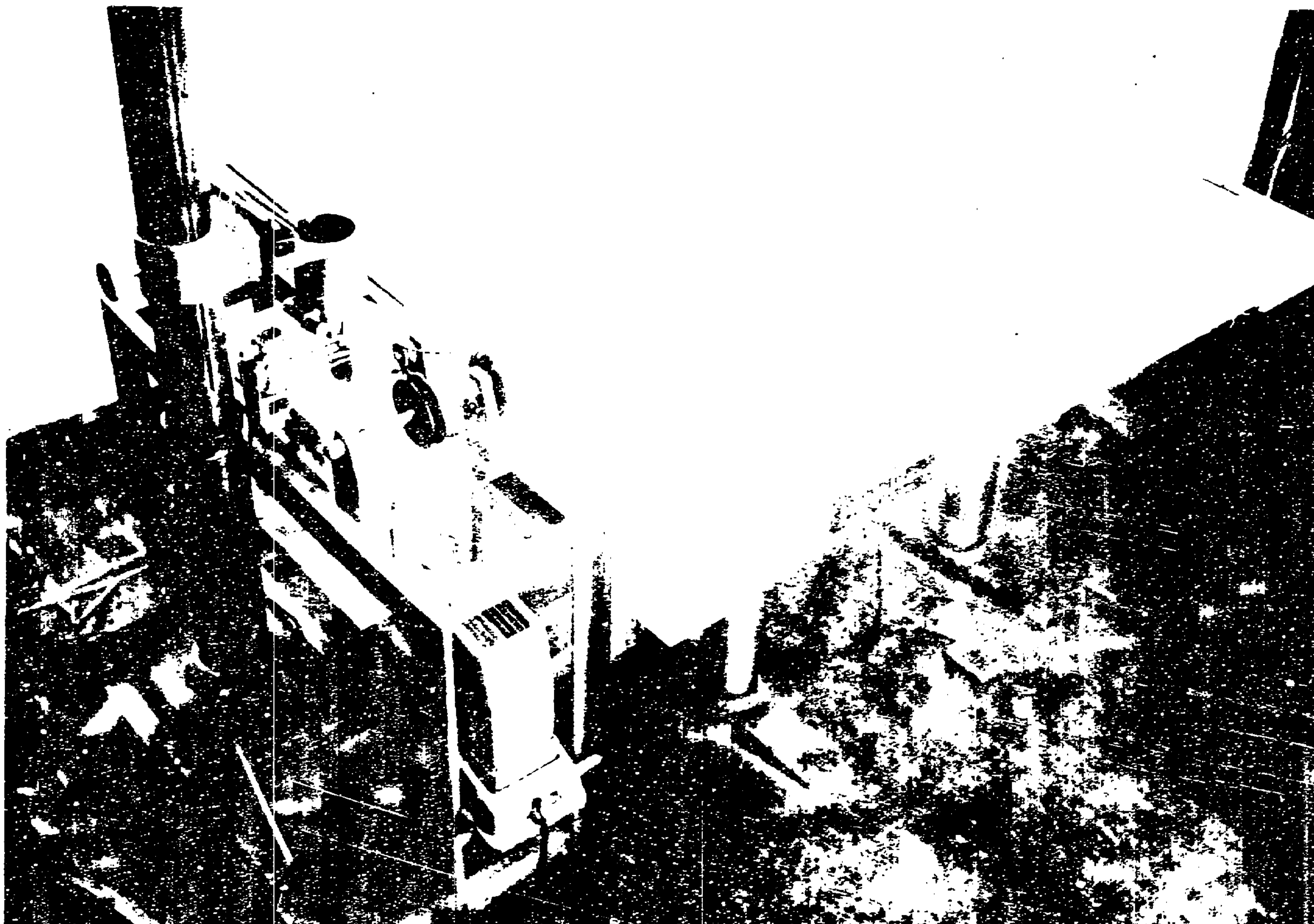
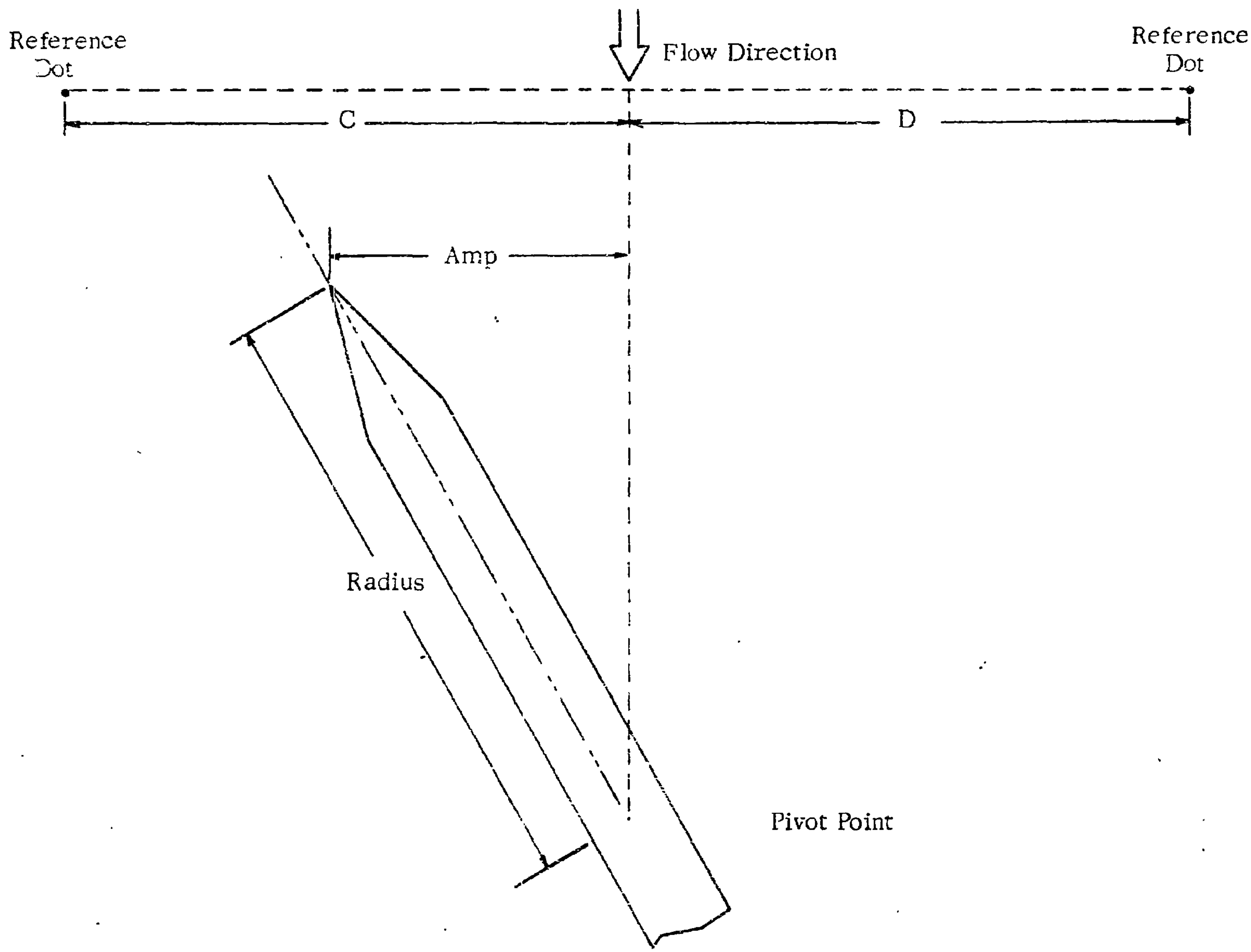


Figure 15. Optical Comparator


Reference
Dot
Flow Direction
Reference
Dot
C
D
Amp
Radius
Pivot Point

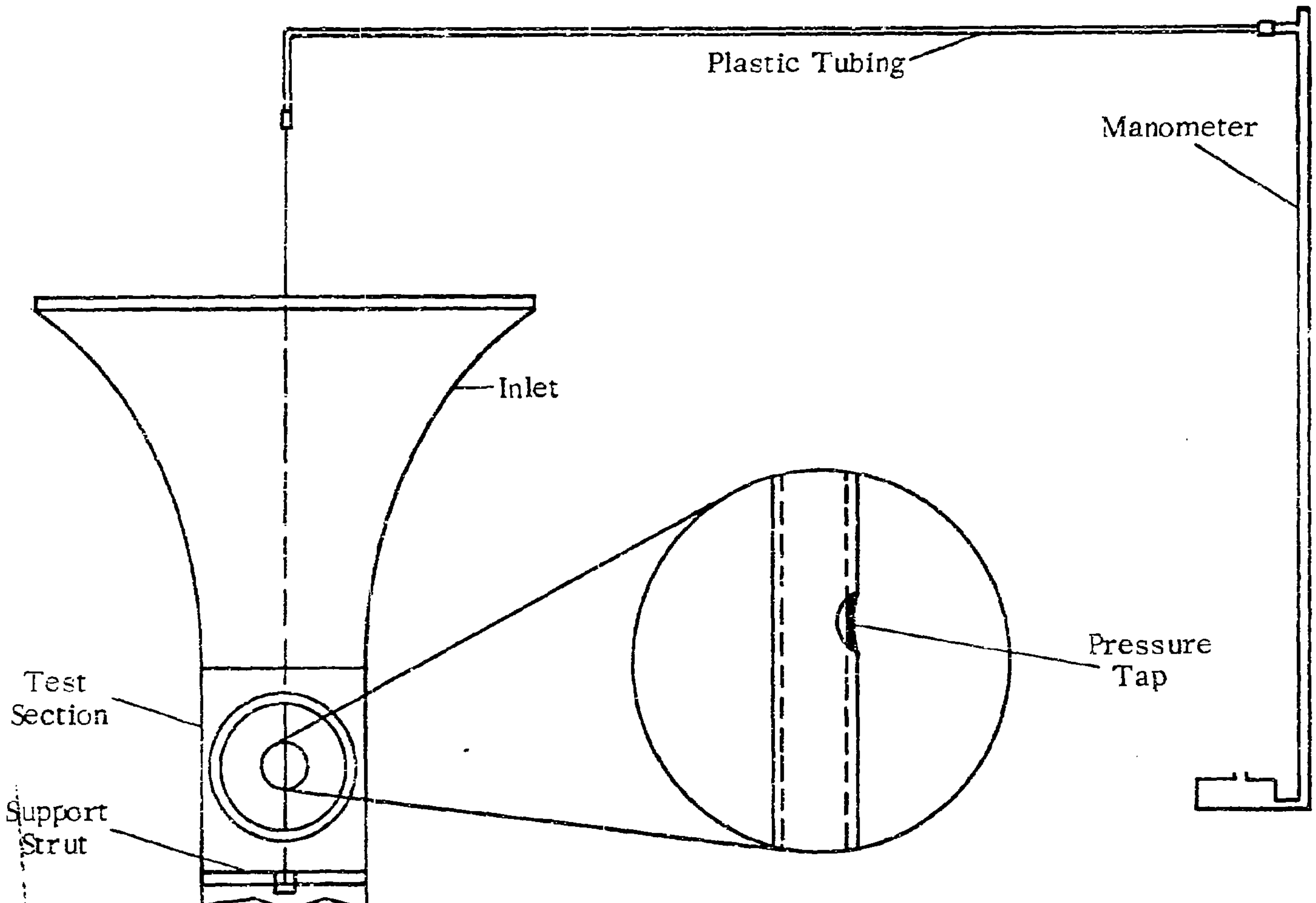


Figure 17. Velocity Measurement Setup

A long thin tube was placed in the inlet of the wind tunnel and lowered until the end reached the support strut just below the test section. This end of the tube was secured to the strut to help maintain the position of the tube near the center of the wind tunnel test section. A small hole had been drilled in the side of the tube to coincide with the position of the model when the tube was in place. The end of the tube in the tunnel was sealed and the open end was connected to a manometer by a length of plastic tubing. This upper end was fastened so as to put tension on the tube and prevent it from moving about in the test section when the pressure measurement was being taken. Any movement of the tube would affect the pressure reading and produce an incorrect value of the velocity.

Before starting the tunnel a tare reading was made on the manometer and the stagnation or total pressure was taken from a barometer. Since the manometer scale did not coincide with that of the barometer the tare reading and barometer reading, which should have been equal had their scales coincided, were different. This difference was a correction factor which would have to be added to the pressure reading taken when the tunnel was on to give the actual static pressure. The tunnel was turned on and the pressure was recorded. Having all of these pressure readings the ratio of static to total pressure could be solved for using the following formula:

$$\frac{P}{P_t} = \frac{P_{read} + (P_t - P_{tare})}{P_t}$$

where

$$(P_t - P_{tare}) = \text{correction factor}$$

Once this ratio was known the Mach number could be found in the Isentropic Flow Tables of Reference 8. For the REDUCE computer program it was necessary to put the velocity in units of feet per second from the Mach number. A sample calculation of this is shown in Appendix D.

ONE-DEGREE-OF-FREEDOM TEST RESULTS

~~One-Degree-of-~~Freedom Data Reduction

The WOBBLE computer program was used to fit the Aeroballistic Theory to the one-degree-of-freedom angular data obtained from the REDUCE program. The data was fitted in segments of 1.8 cycles and the stability parameters K_1, K_T, λ_1, and ω_1 were determined by WOBBLE at a time interval of 0.03 seconds. The stability parameter K_T, the trim arm, is analogous to the K_3 in the Linear Theory and is due to aerodynamic asymmetries in the configurations. The average percent error of the fitting of the theory to the data for all the tests carried was less then 3%. A representative plot of probable error (P.E.) versus time is given in Figure 18. The stability parameters were obtained from the fits as functions of time. Plots of the stability parameters versus time for all the configurations are presented in Figures 19 through 34.

One-Degree-of-Freedom Stability Coefficients

The pitching moment and damping moment stability coefficients, C_{M_α} and $(C_{M_q} + C_{M_{\dot\alpha}})$, were obtained versus time from the WOBBLE fits. Plots of the mean values of the coefficients per fit versus mean angle of attack per fit are presented in Figures 35 through 42 for all the configurations. These plots given an approximation of how the coefficients vary with angle of attack. Included on these graphs are Ballistic Range Laboratory (BRL) results for the respective configurations and coefficients. The BRL data was plotted at an angle of attack of 2^{o}. Figures 43 through 50 are plots of BRL results for the stability coefficients versus Mach number for all the configurations. Mean values of the Notre Dame results for the coefficients at low angles of attack are included on these graphs. The Notre Dame data was plotted at a Mach number of 1.3 which was an average value of all the tests carried out.

An important point which should be brought up at this point is the discrepancy in the definition of the damping moment stability coefficient between the two sets of results. The computations in this investigation were carried out using a factor of $(\frac{d}{2u})$ in the definition of the damping moment stability coefficient (see Equation 3). The BRL definition used a factor of $(\frac{d}{u})$ causing the respective computed values of $(C_{M_q}+C_{M_{\dot{\alpha}}})$ to be off by a factor of two. To account for this and allow the results to be directly compared, the BRL values of $(C_{M_q}+ C_{M_{\dot{\alpha}}})$ were increased by a factor 2 before plotting. This essentially gave all the values presented a uniform definition and allowed the comparisons of the results to be made.

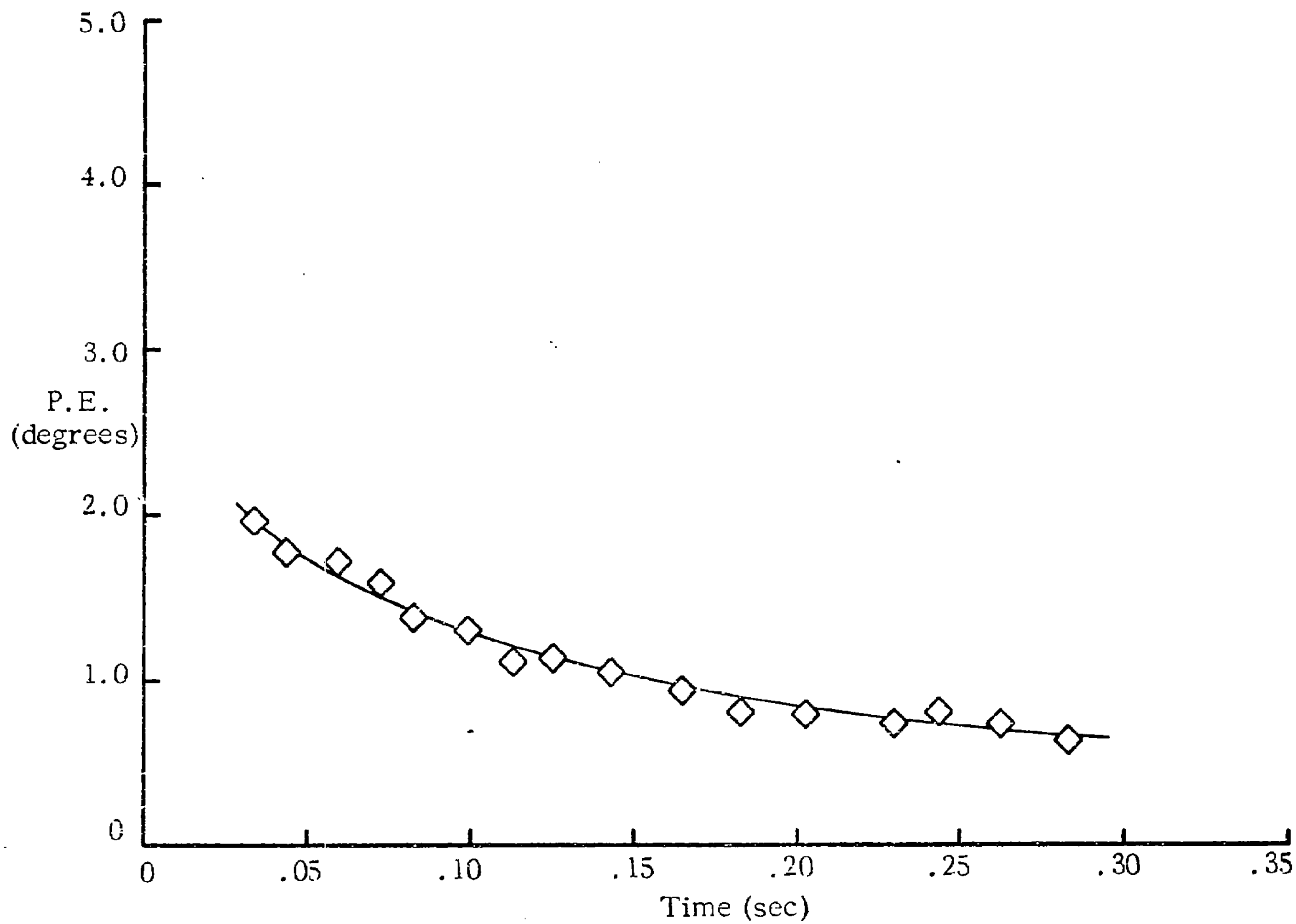


Figure 18. Probable Error versus Time

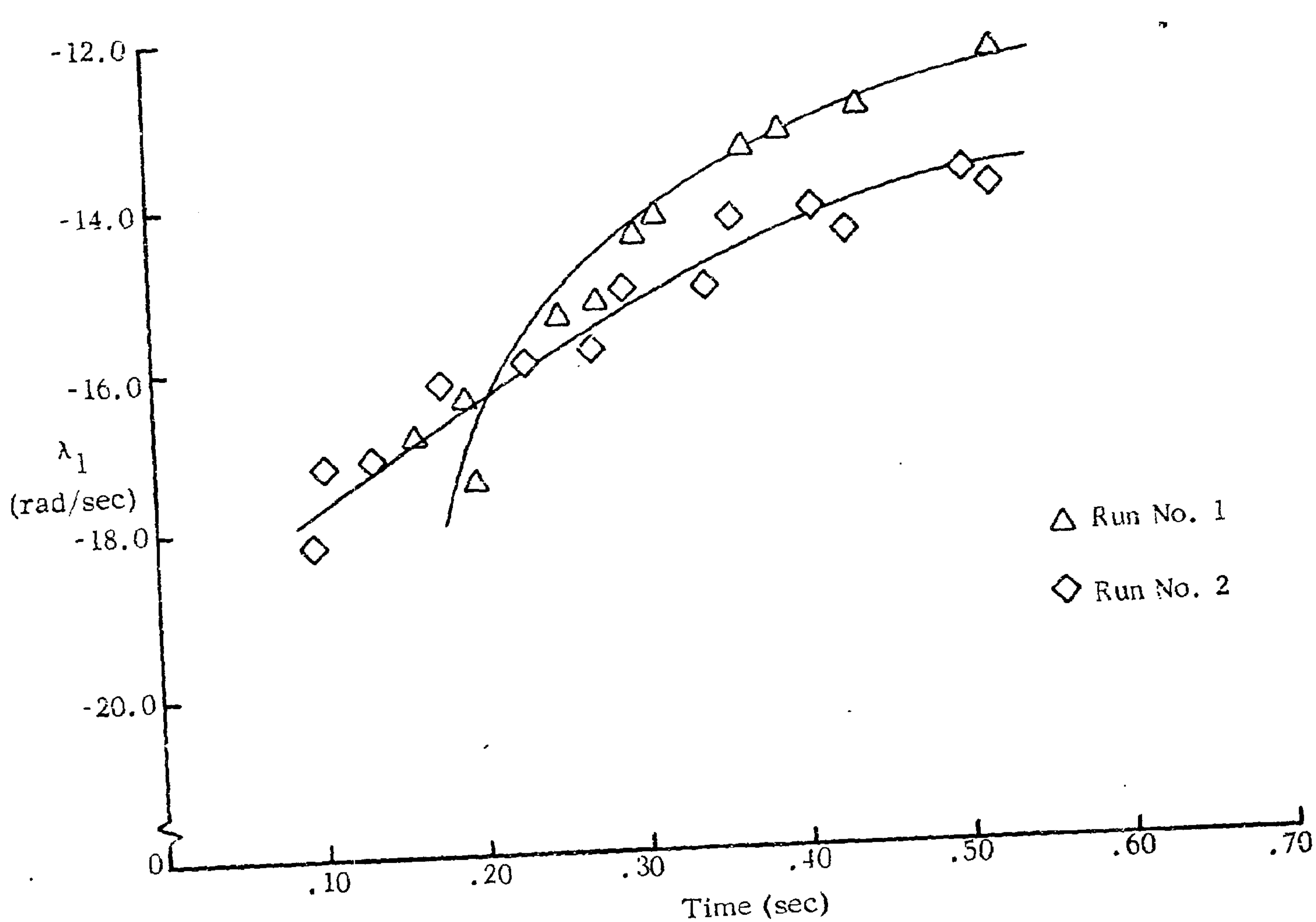


Figure 19. λ_1 versus Time (Ground Point)

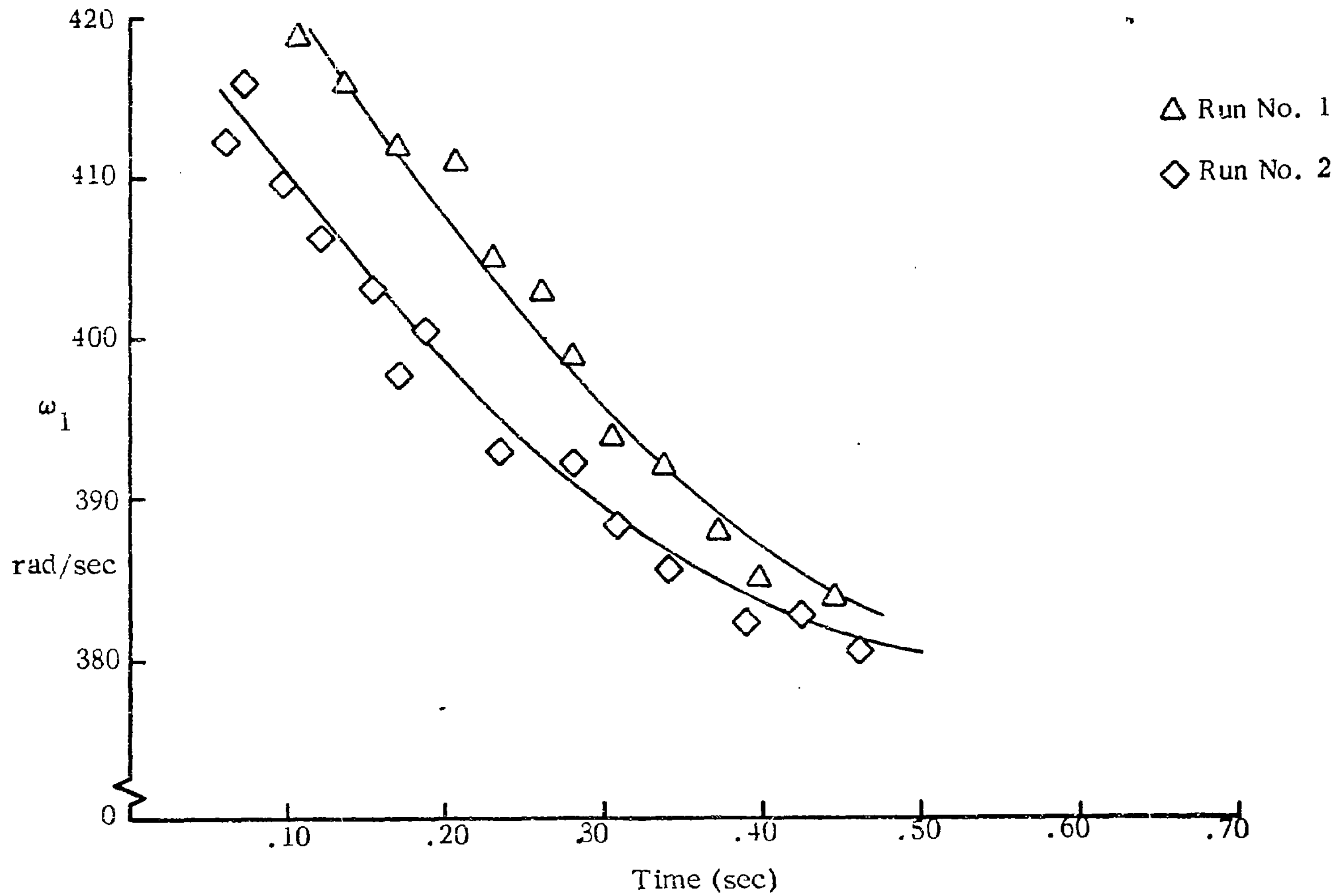


Figure 20. ω_1 versus Time (Ground Point)

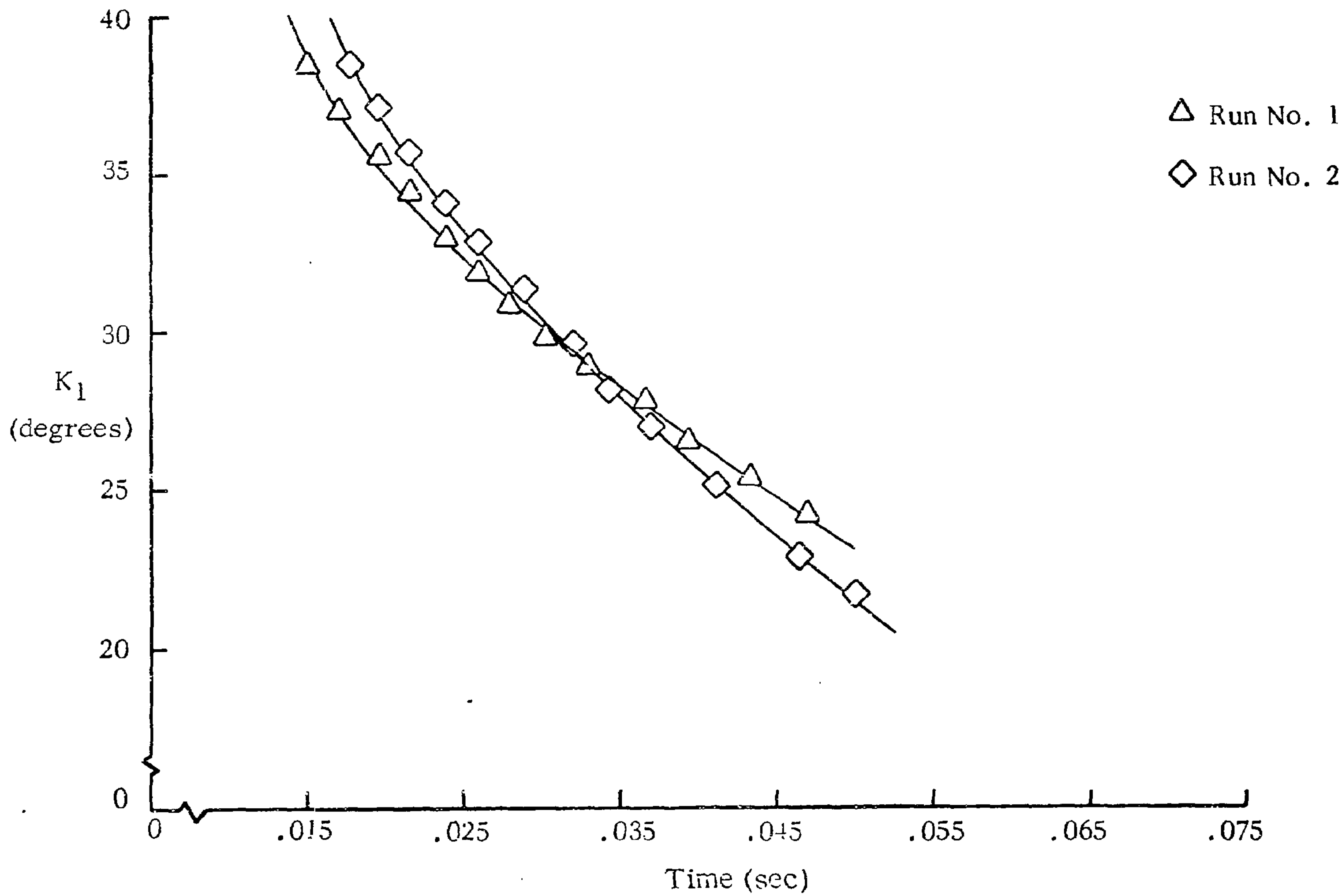


Figure 21. K_1 versus Time (Ground Point)

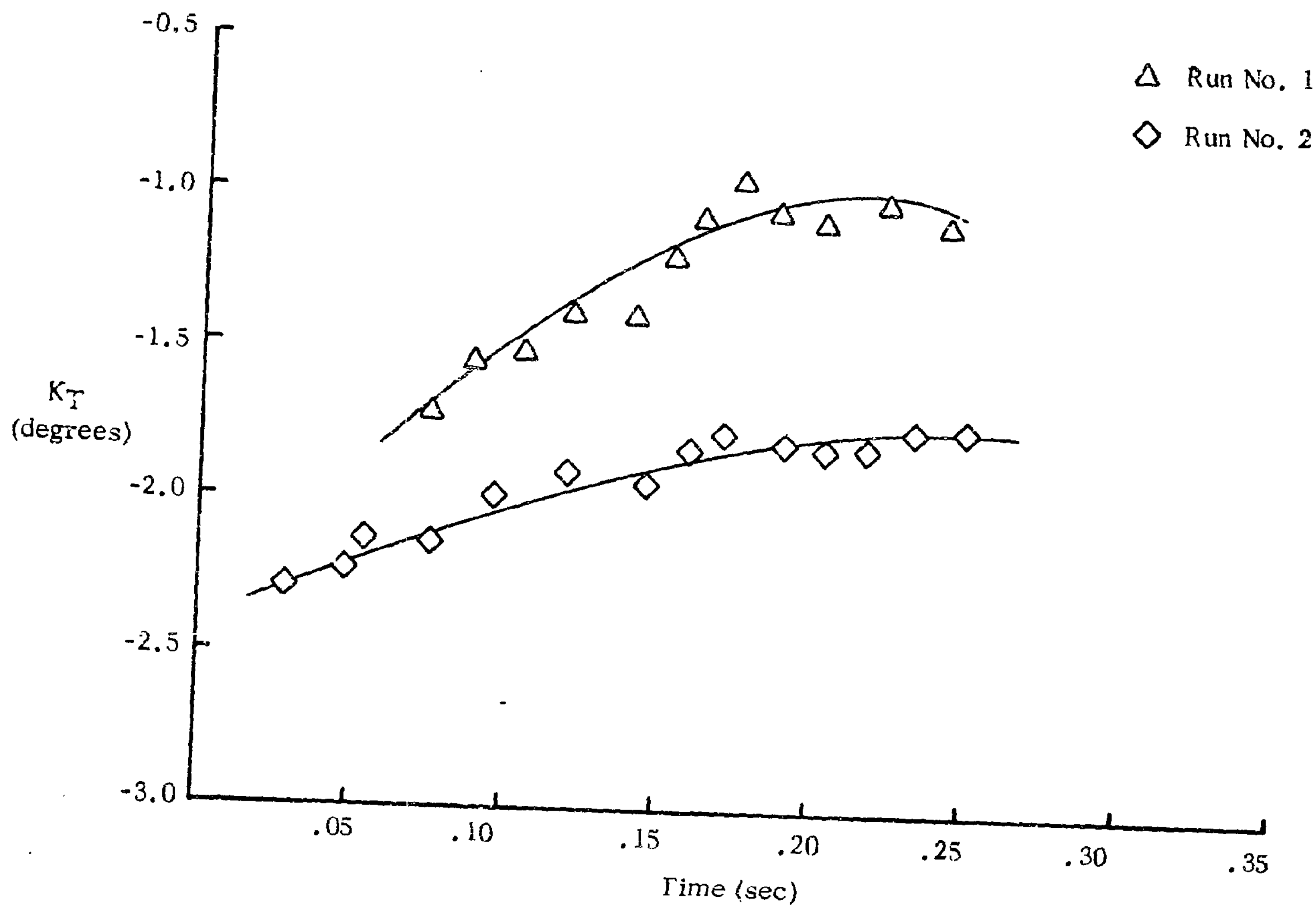


Figure 22. K_T versus Time (Ground Point)

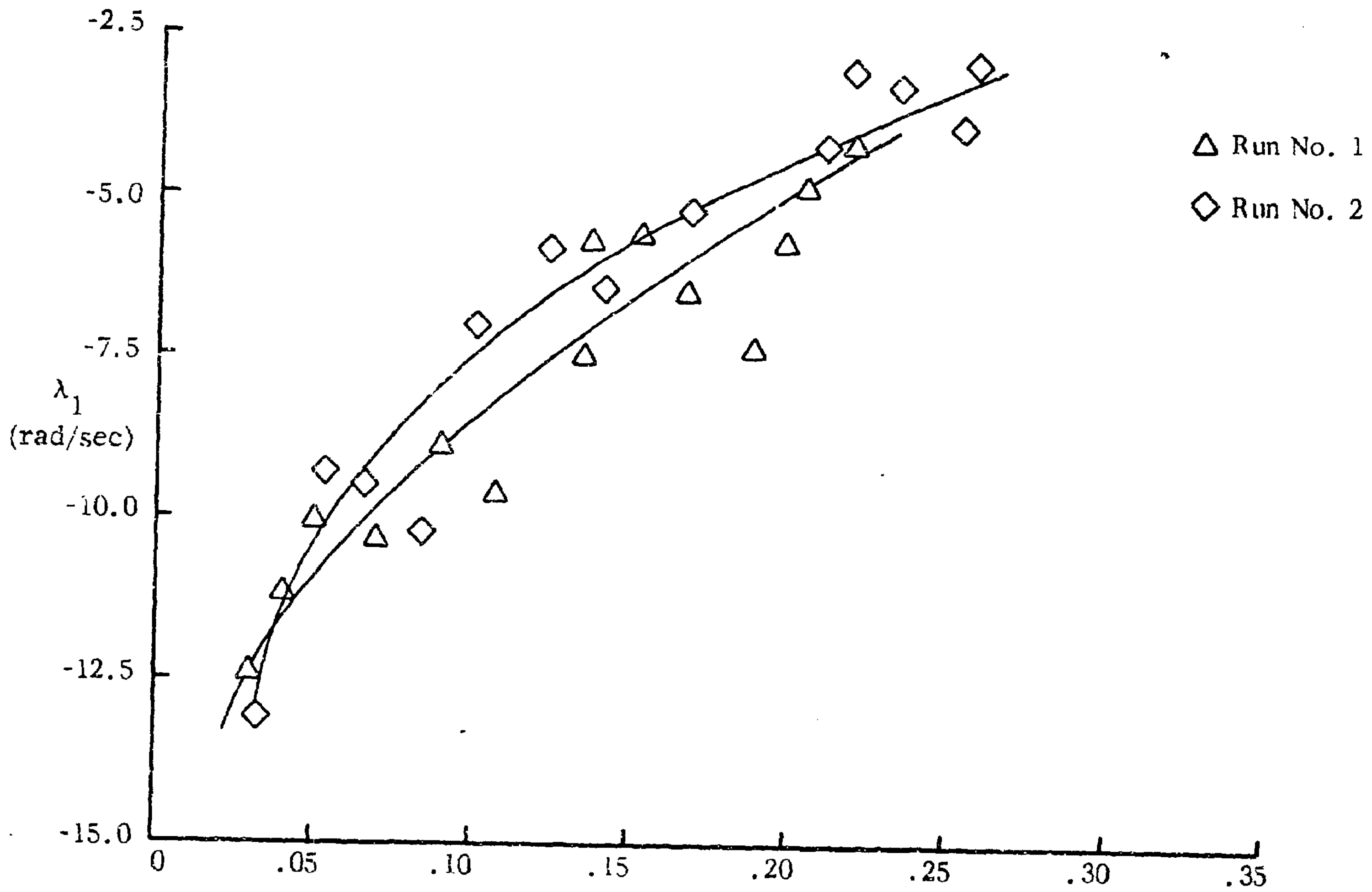


Figure 23. λ_1 versus Time (Olin)

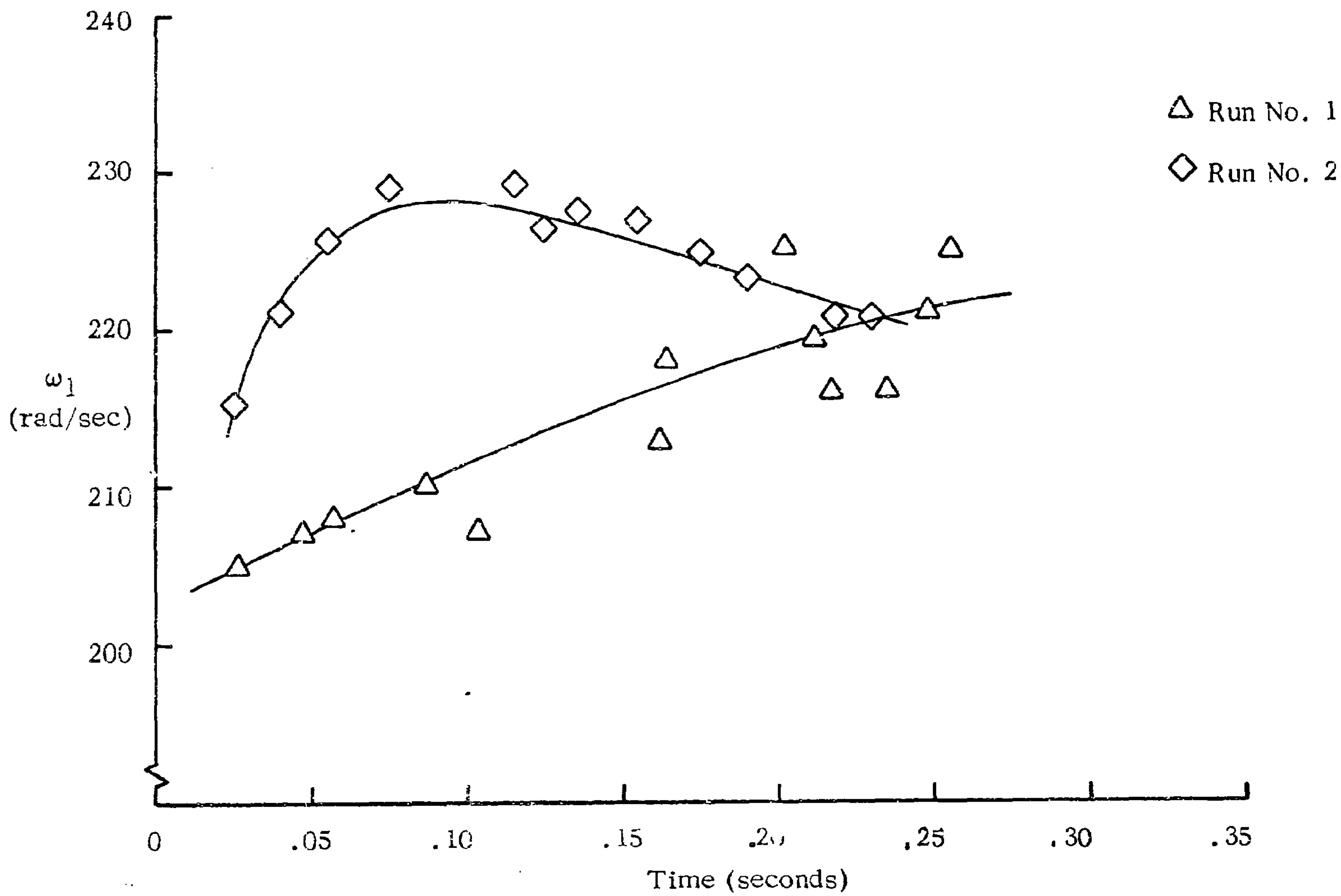


Figure 24. ω_1 versus Time (Olin)

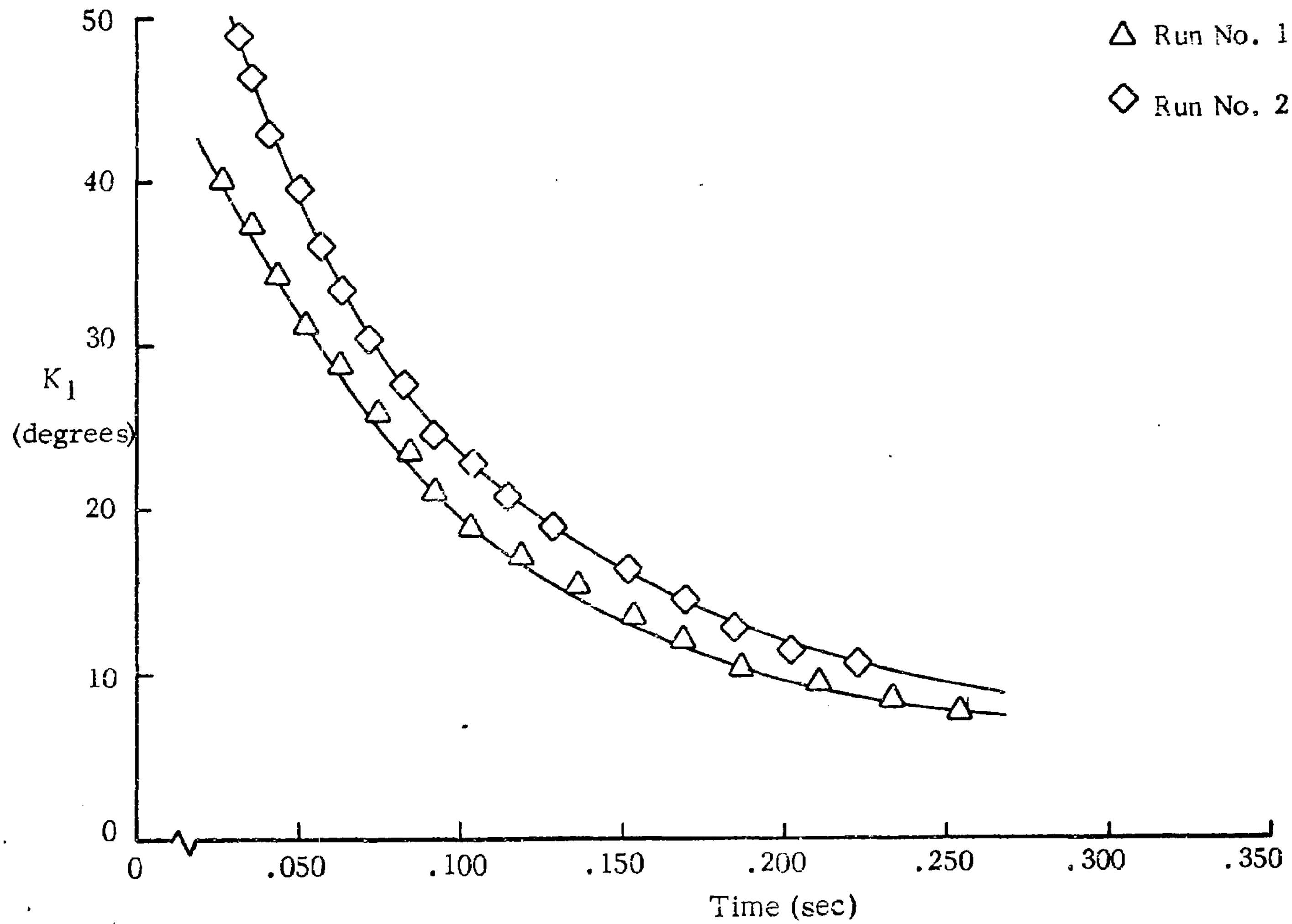


Figure 25. K_1 versus Time (Olin)

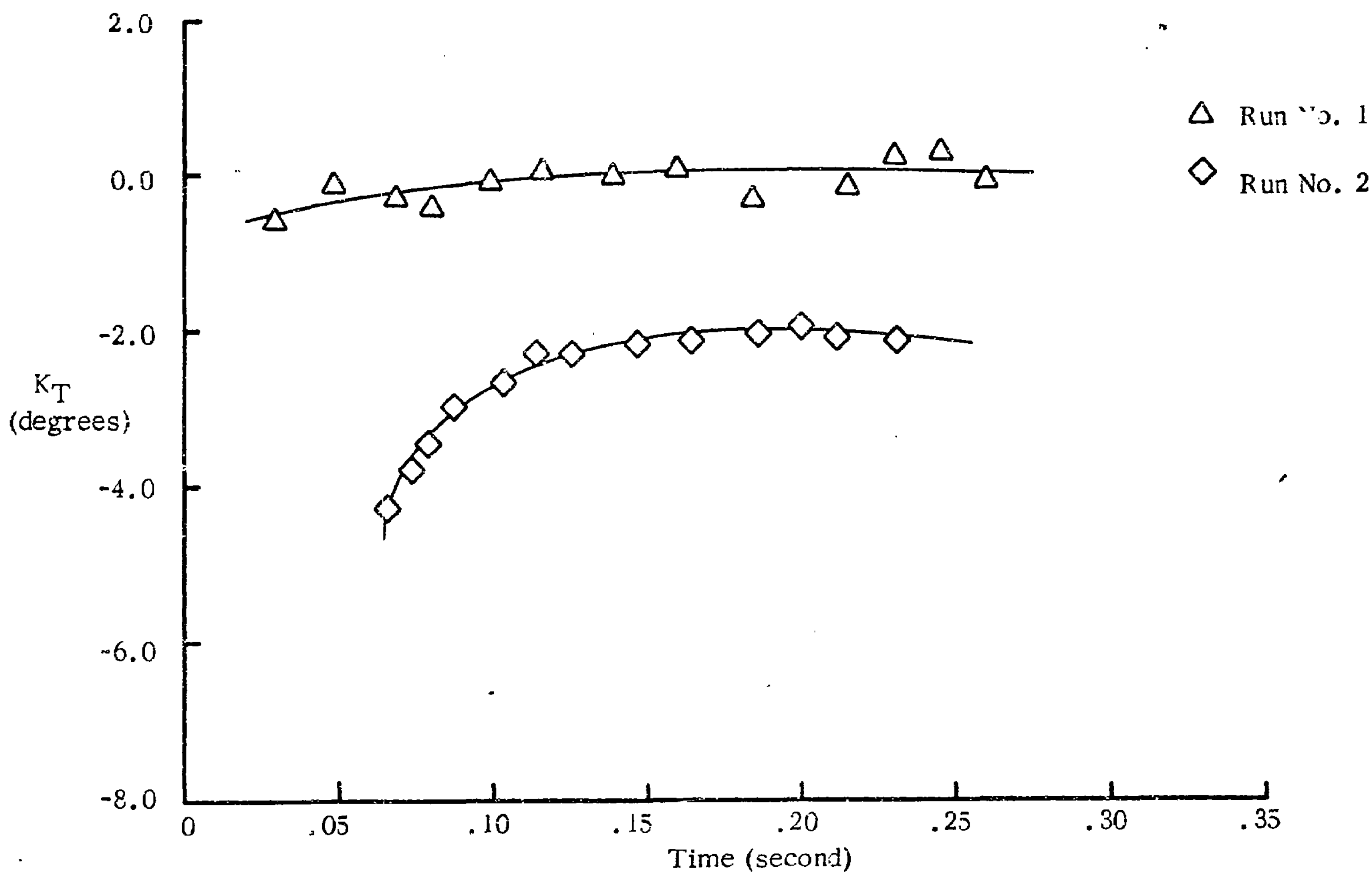


Figure 26. K_T versus Time (Olin)

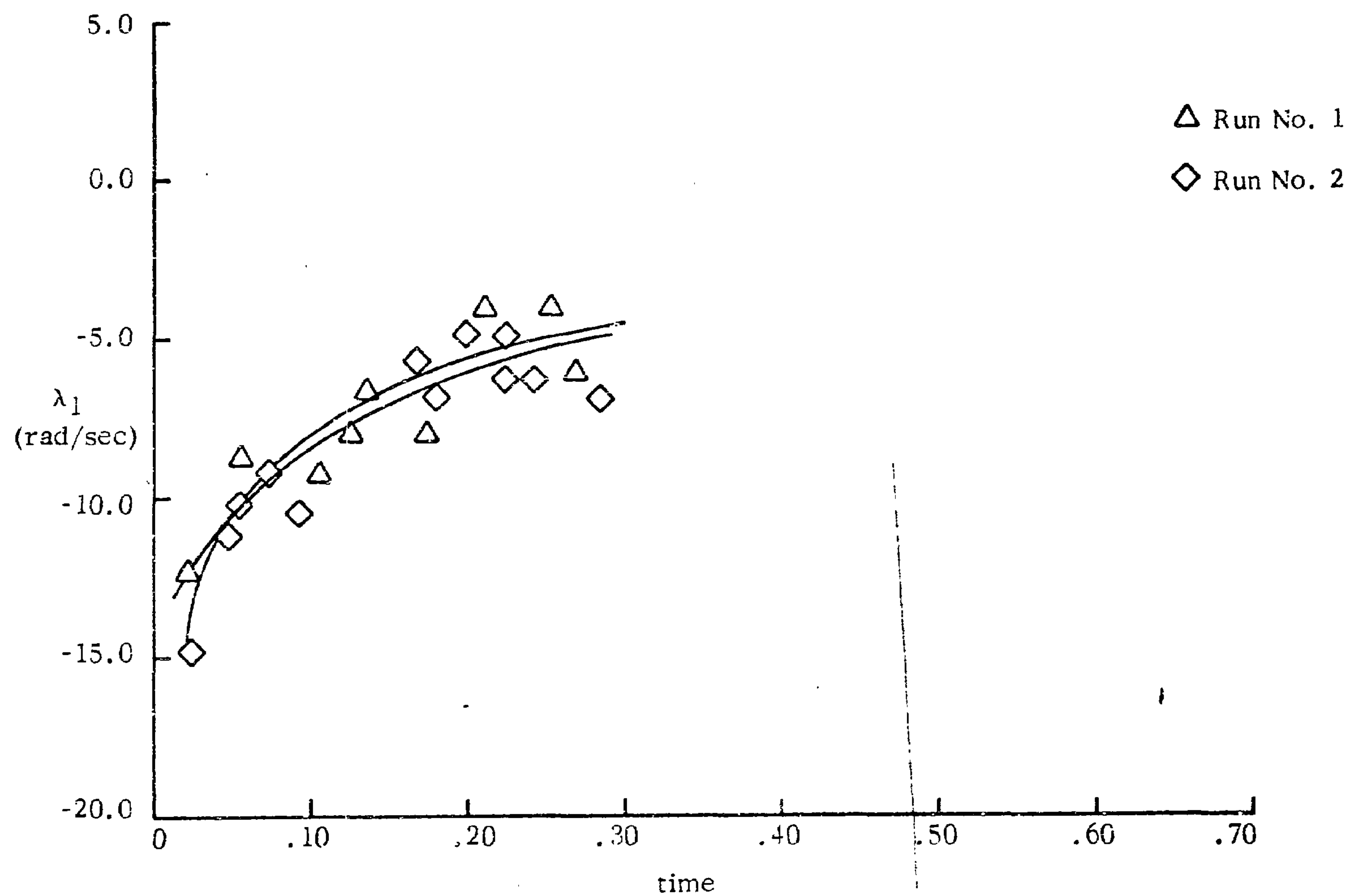


Figure 27. λ_1 versus Time (Swaged Point)

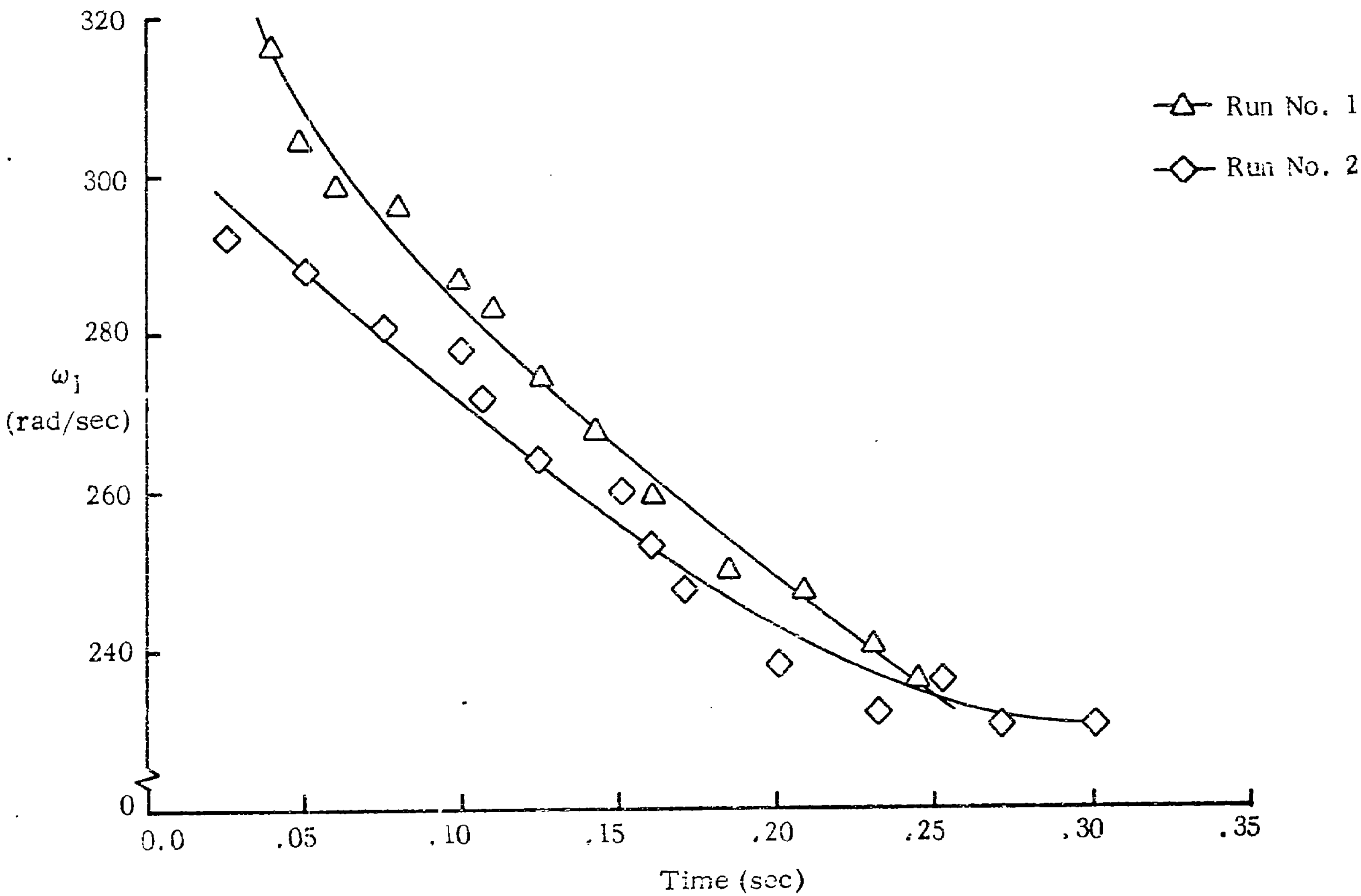


Figure 28. ω_1 versus Time (Swaged Point)

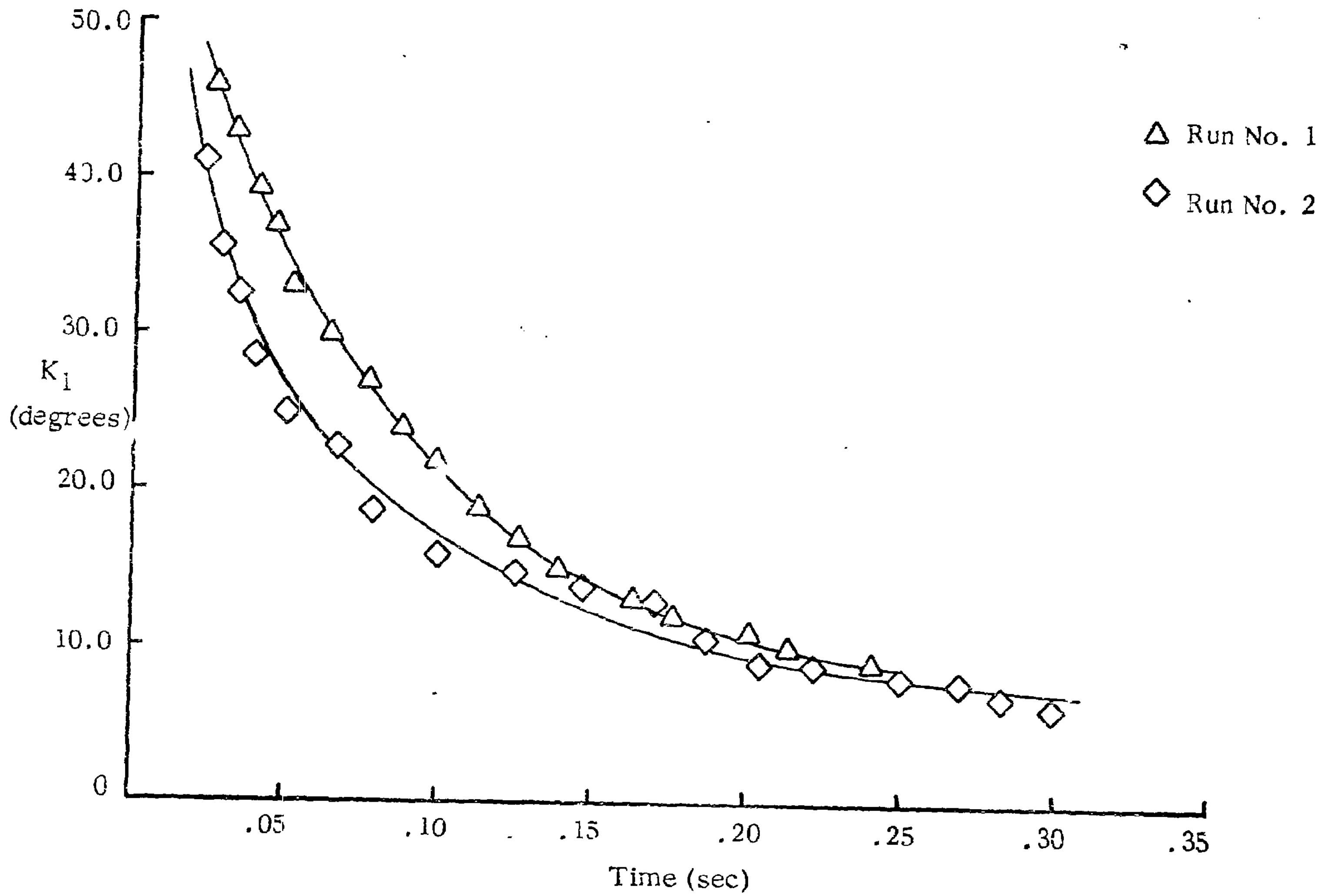


Figure 29. K_1 versus Time (Swaged Point)

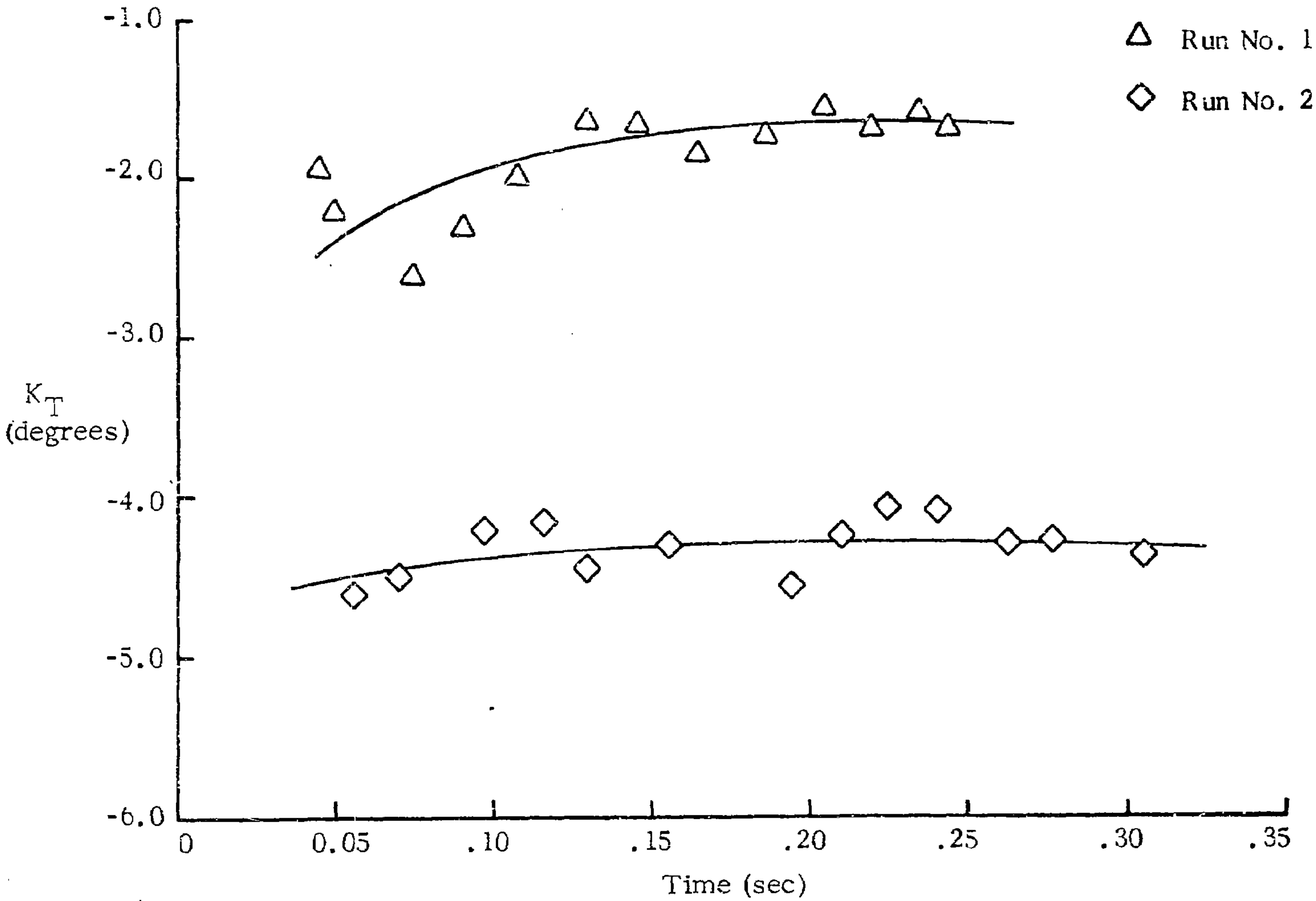


Figure 30. K_T versus Time (Swaged Point)

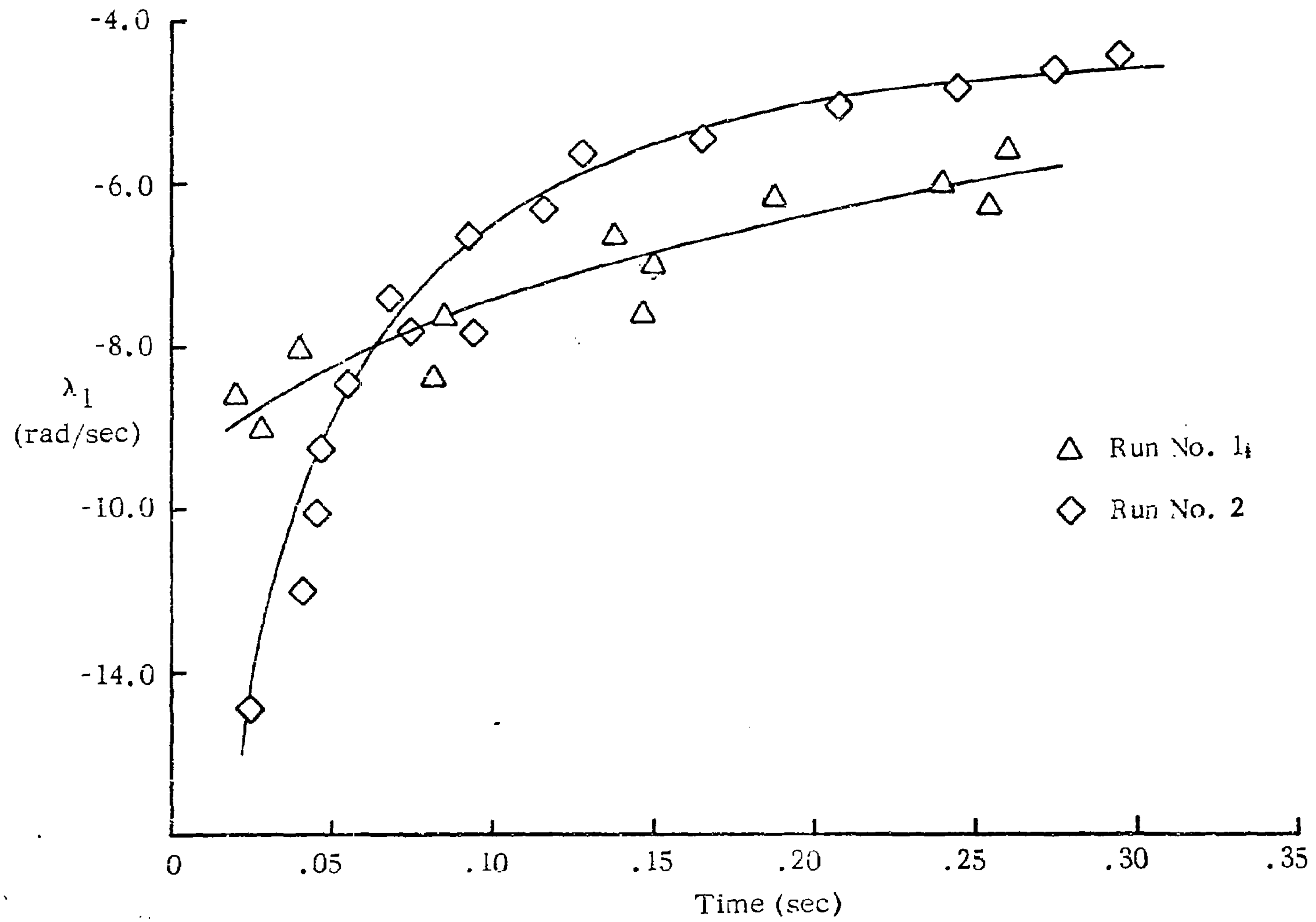


Figure 31. λ_1 versus Time (Tracer)

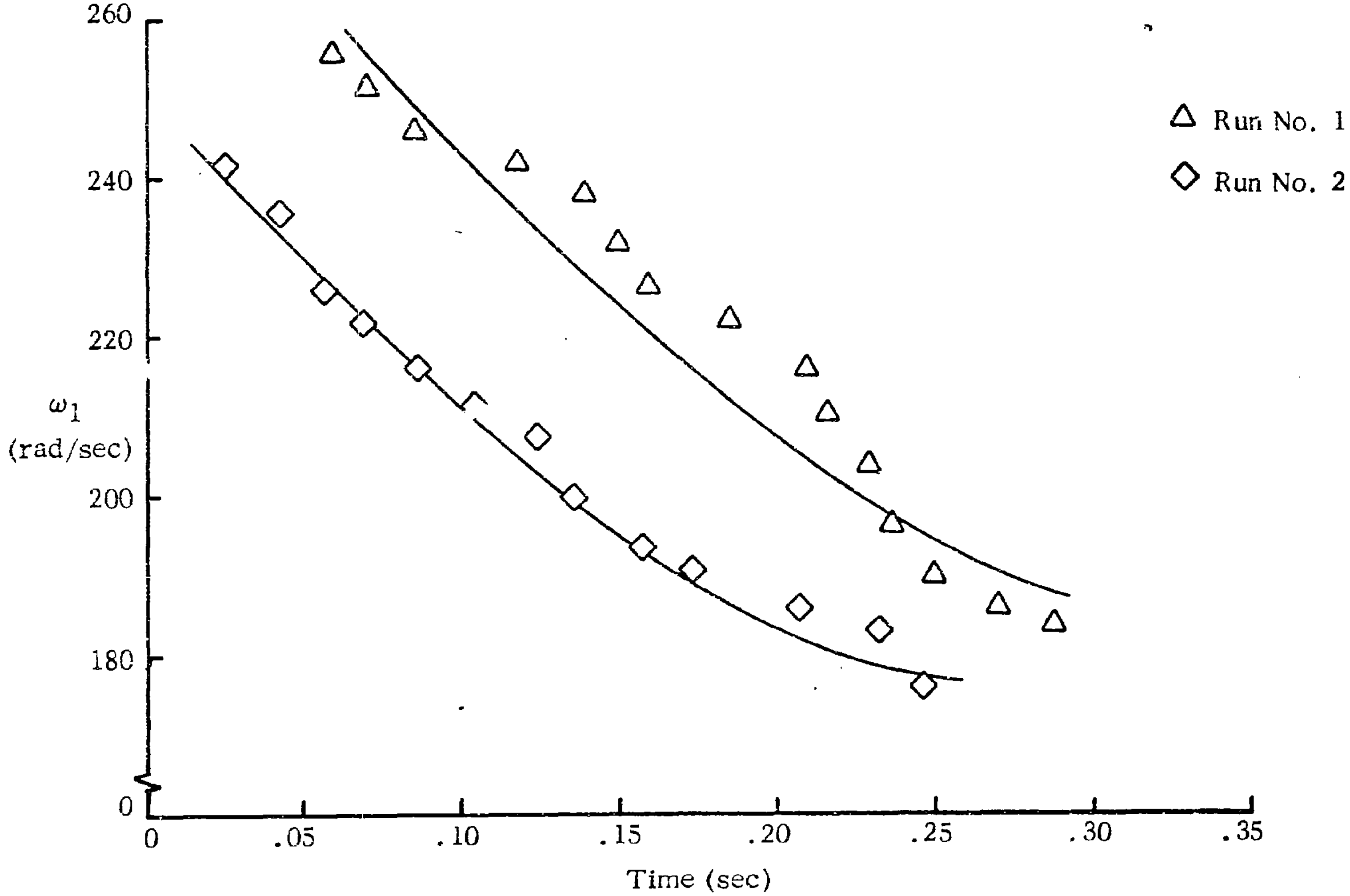


Figure 32. ω_1 versus Time (Tracer)

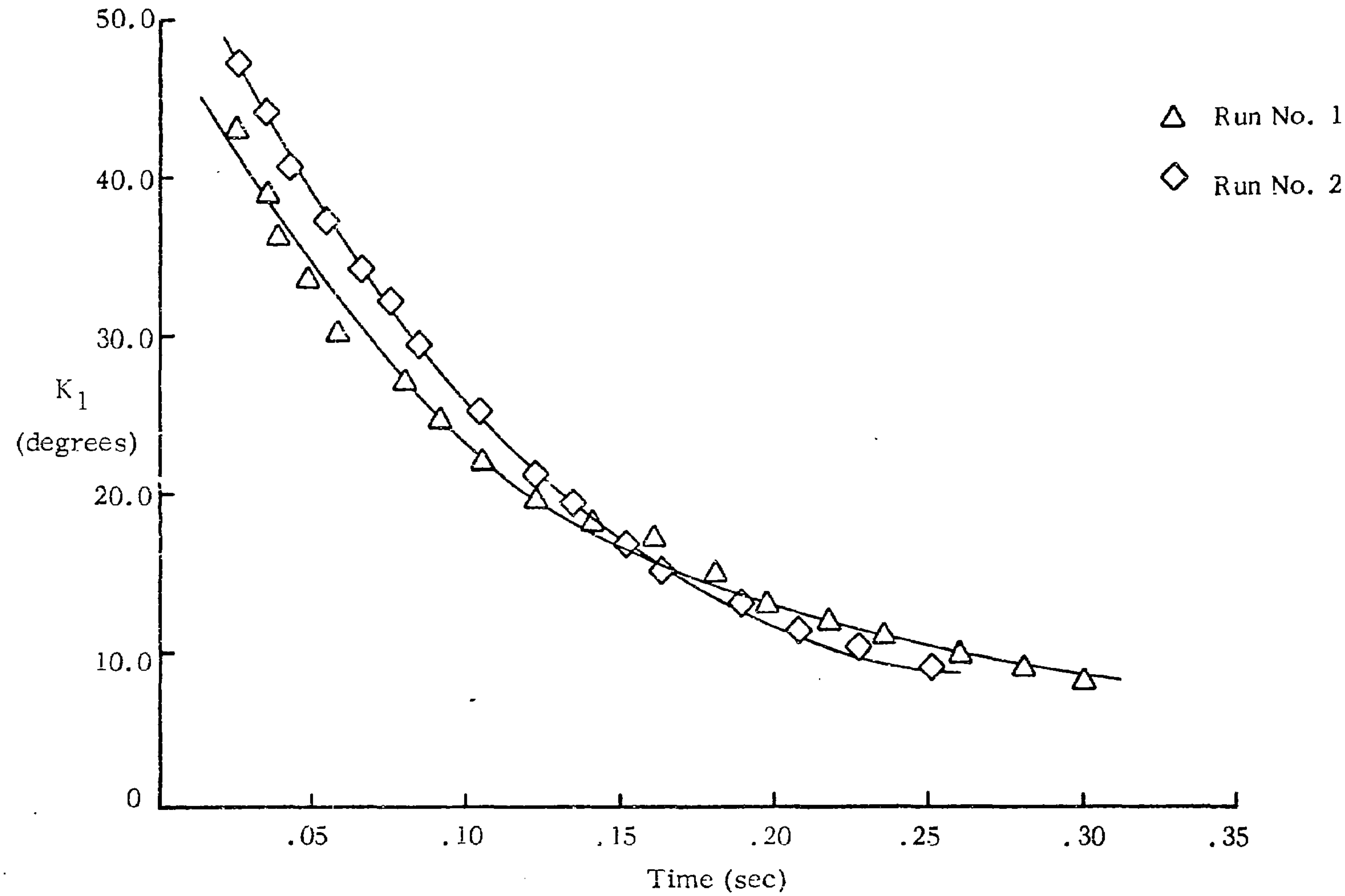


Figure 33. K_1 versus Time (Tracer)

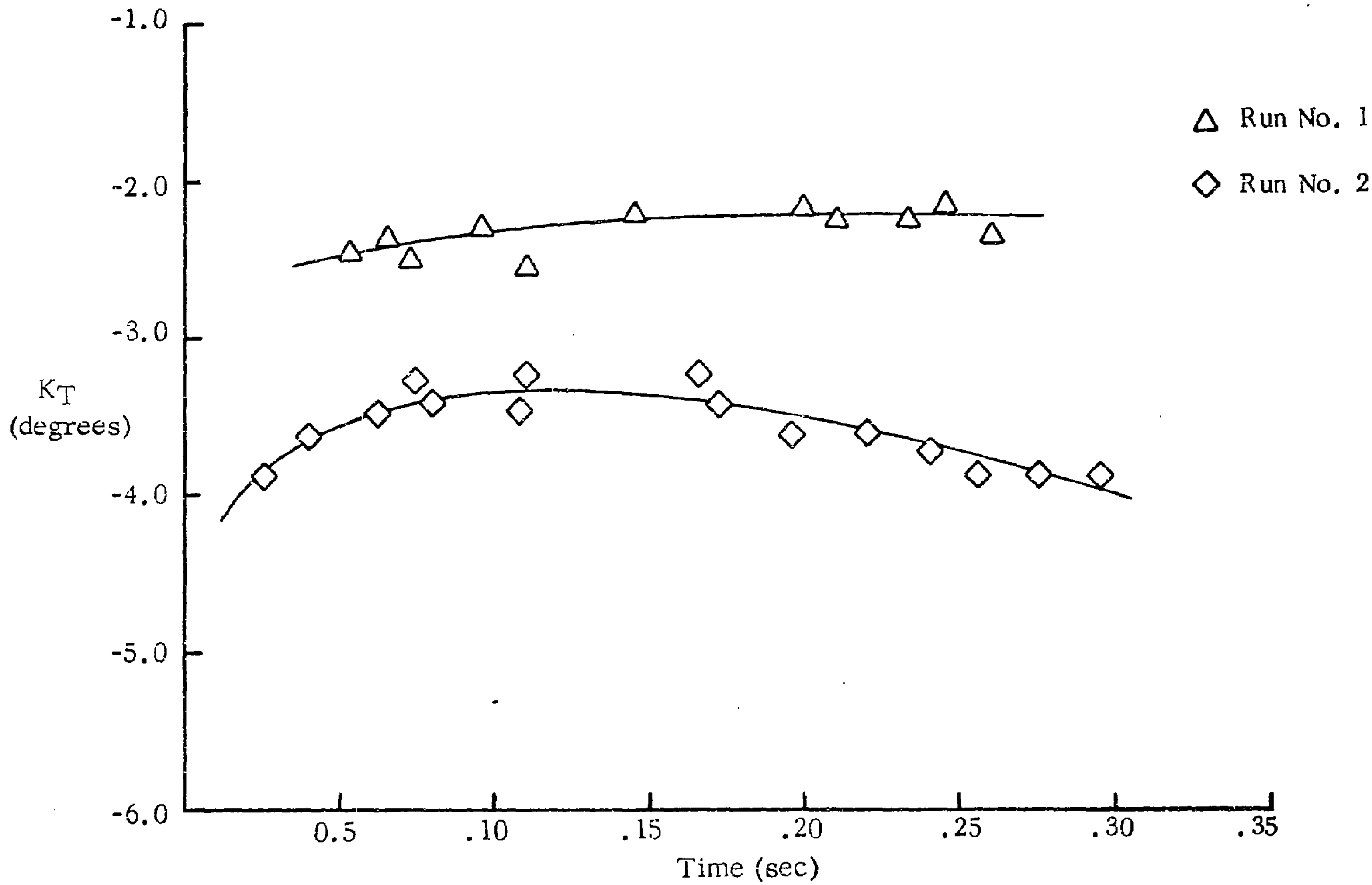


Figure 34. K_T versus Time (Tracer)

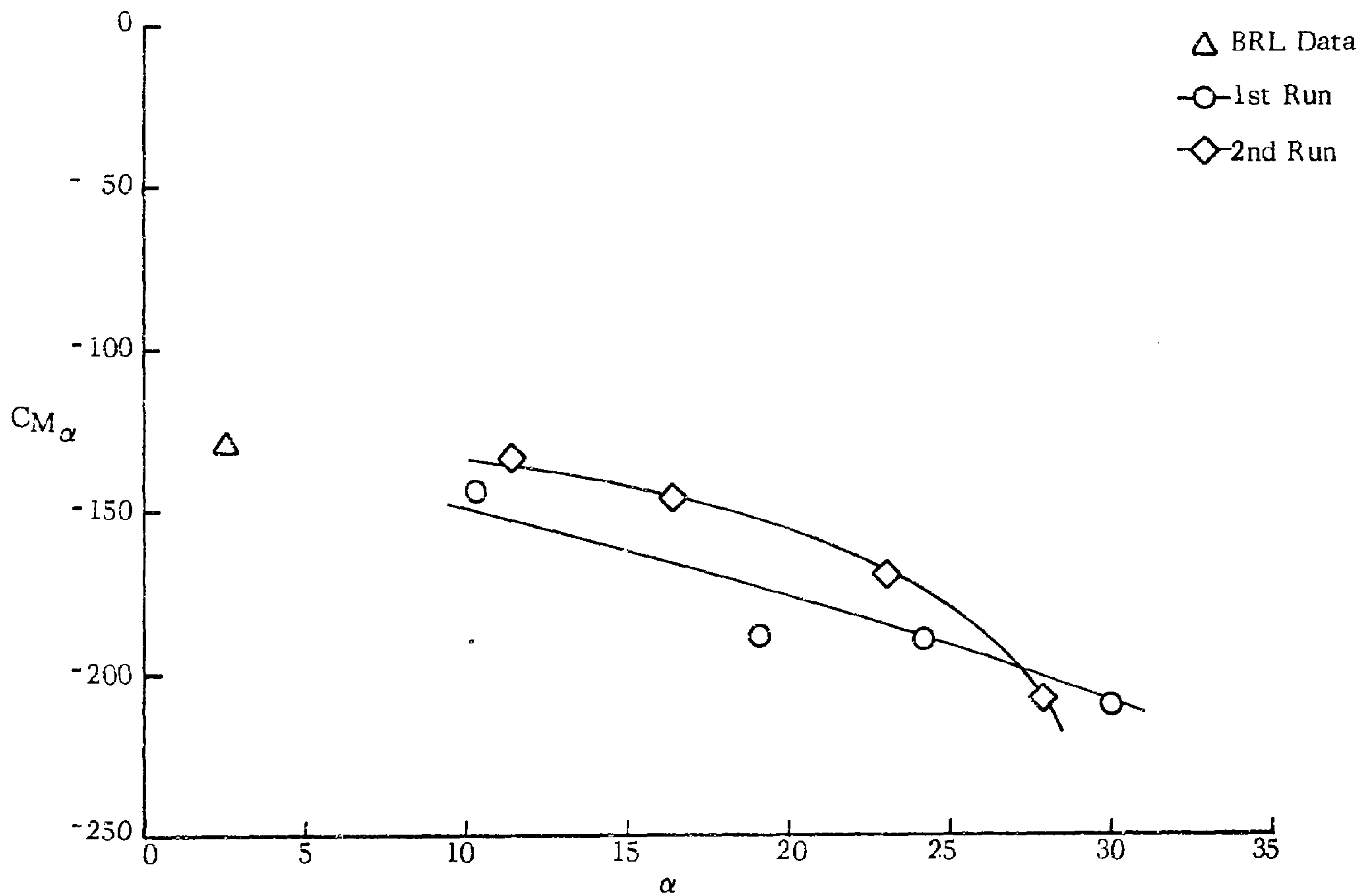


Figure 35. C_{M_α} vs α (Ground Point)

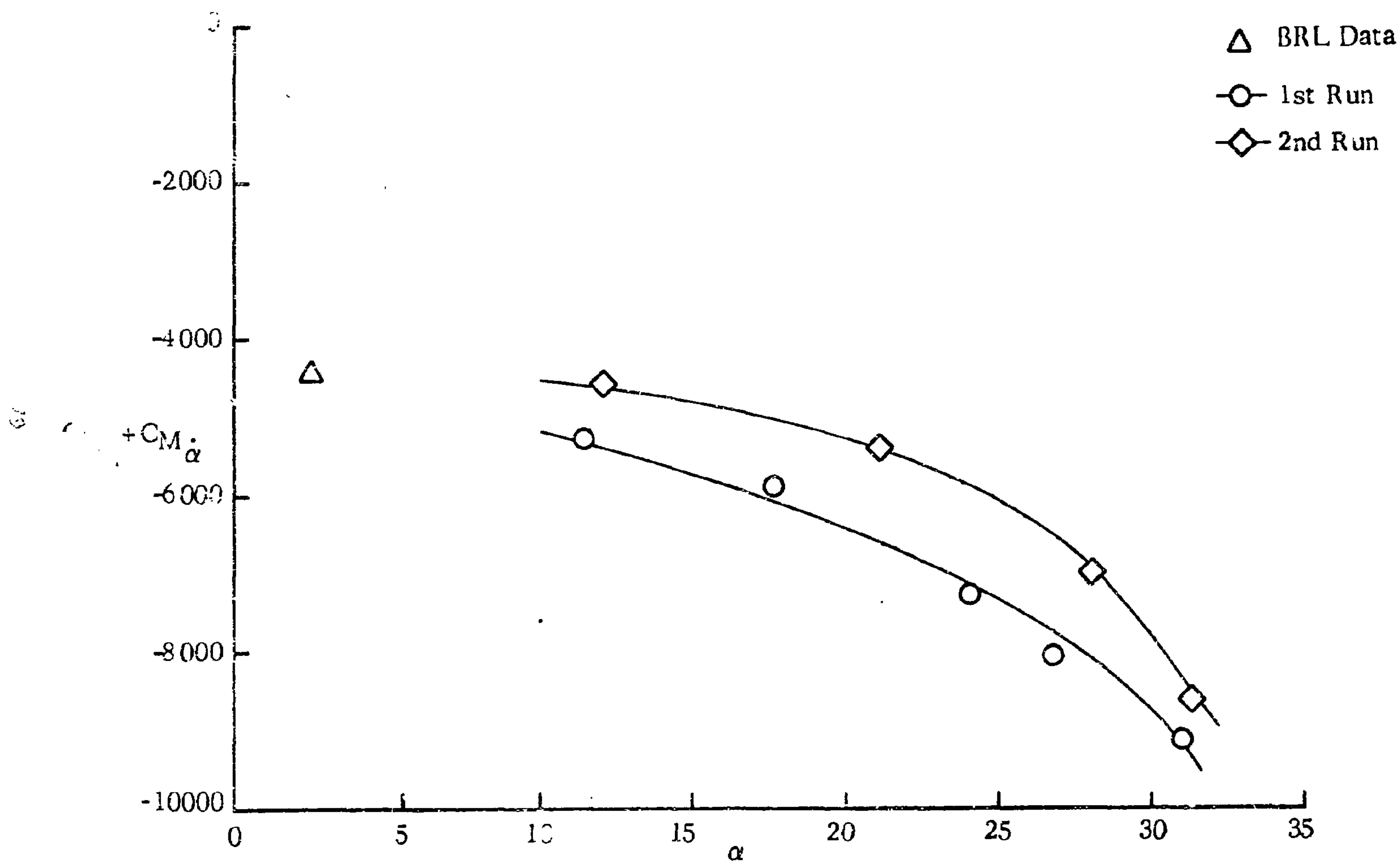


Figure 36. $C_{M_q} + C_{M_{\dot{\alpha}}}$ vs α (G.P.)

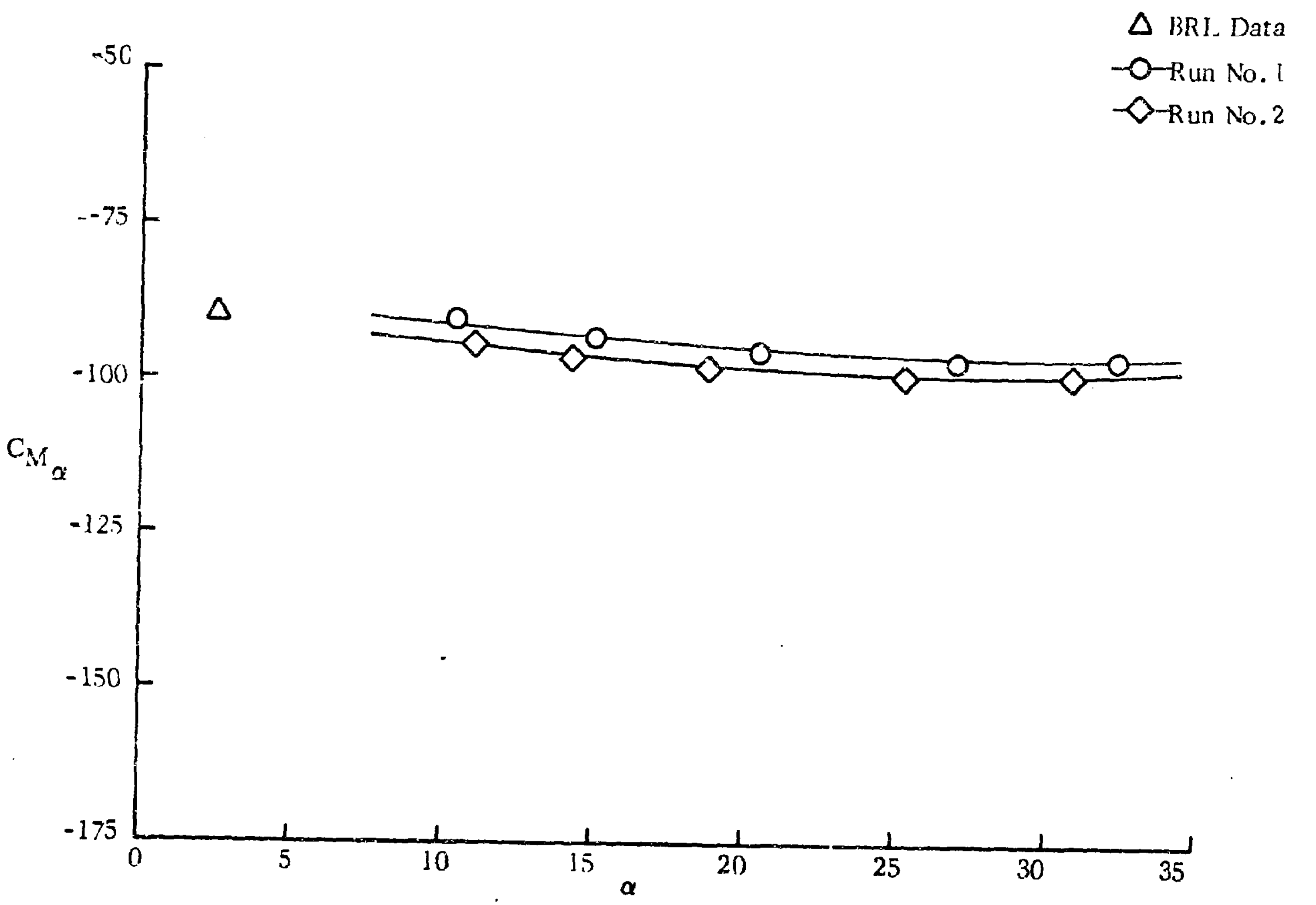


Figure 37. C_{M_α} vs α (Olin)

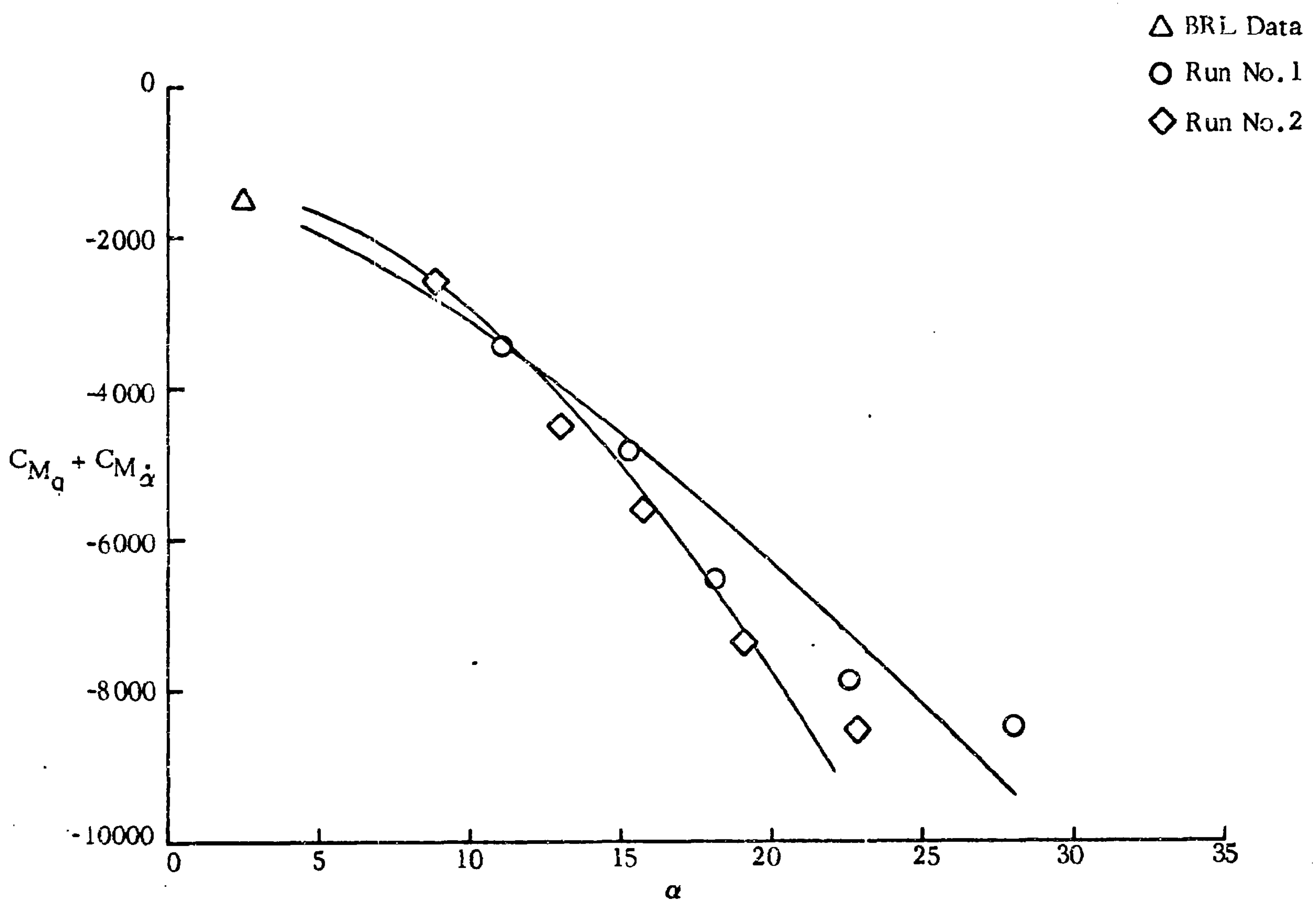


Figure 38. $C_{M_q} + C_{M_{\dot{\alpha}}}$ vs α (Olin)

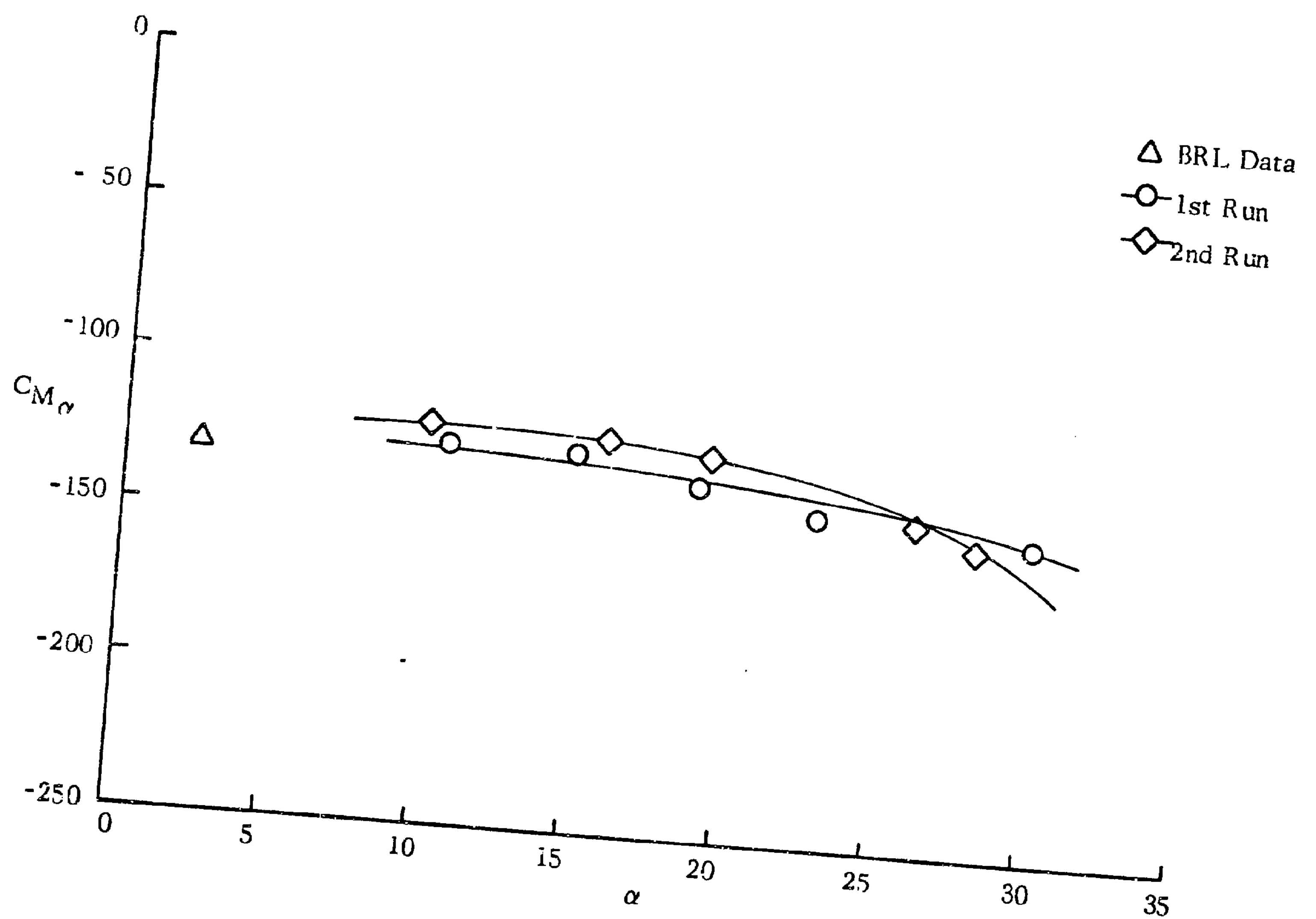


Figure 39. C_{M_α} vs α (Swaged Point)

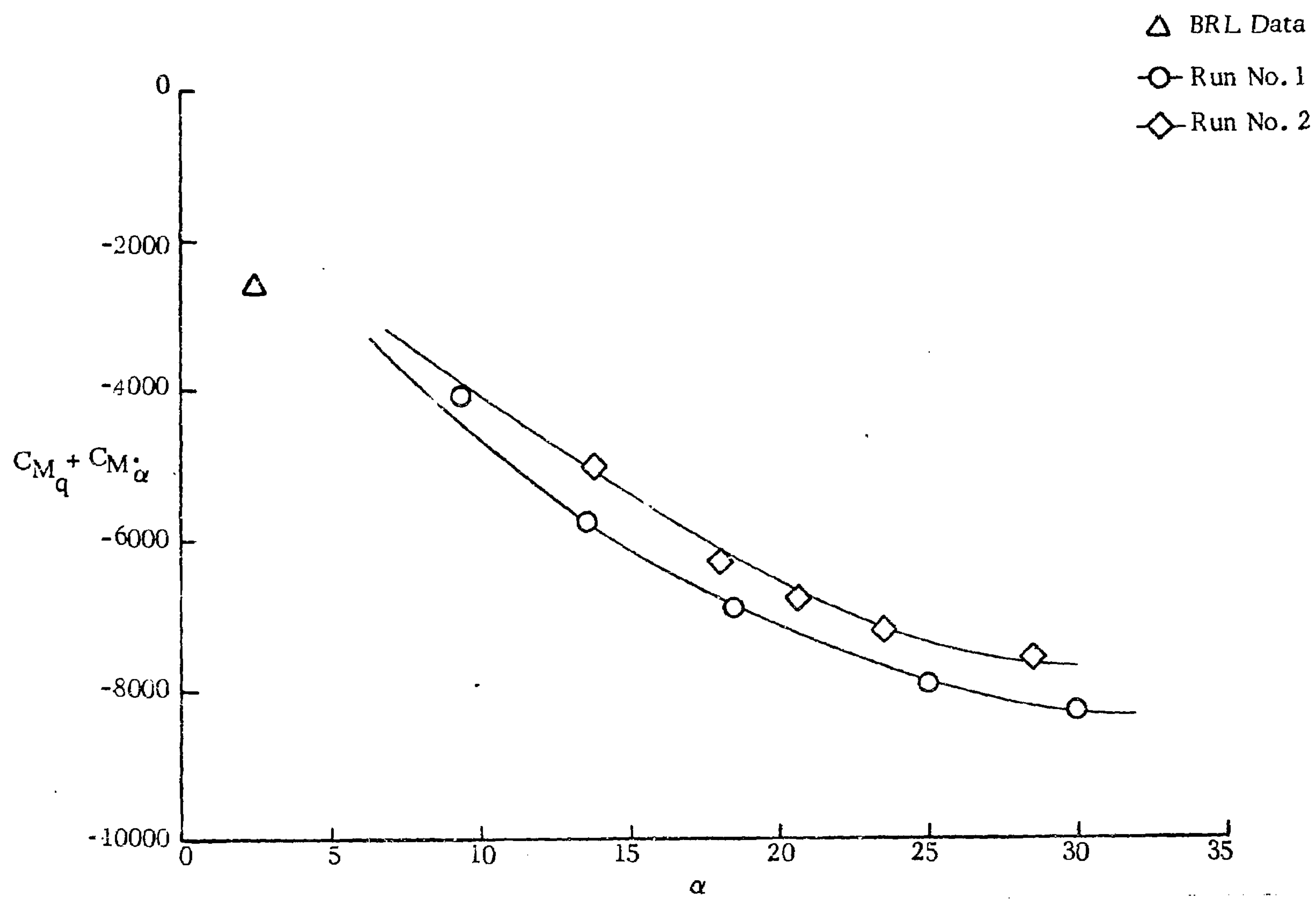


Figure 40. $C_{M_q} + C_{M_{\dot{\alpha}}}$ vs α (Swaged Point)

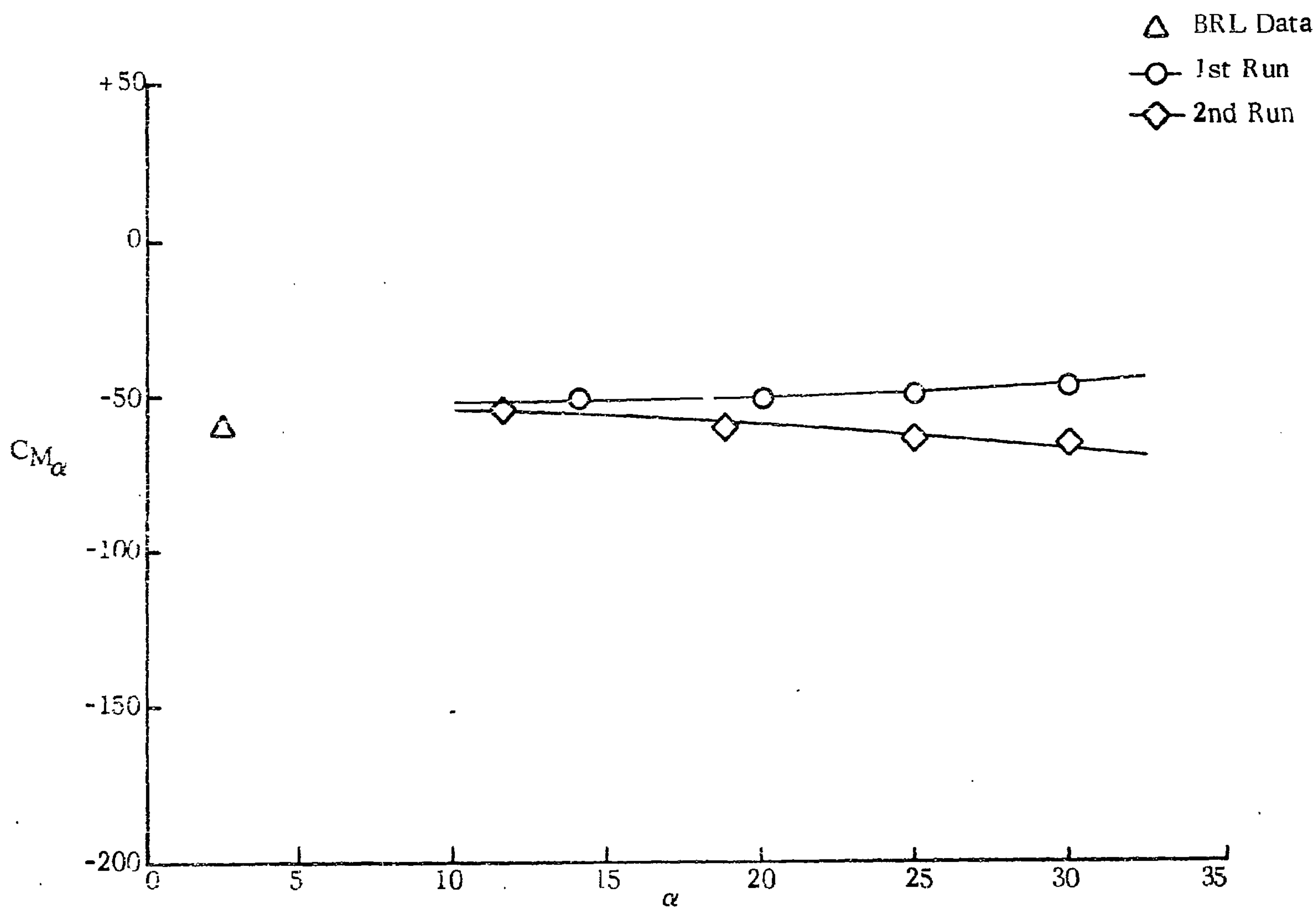


Figure 41. C_{M_α} vs α (Tracer)

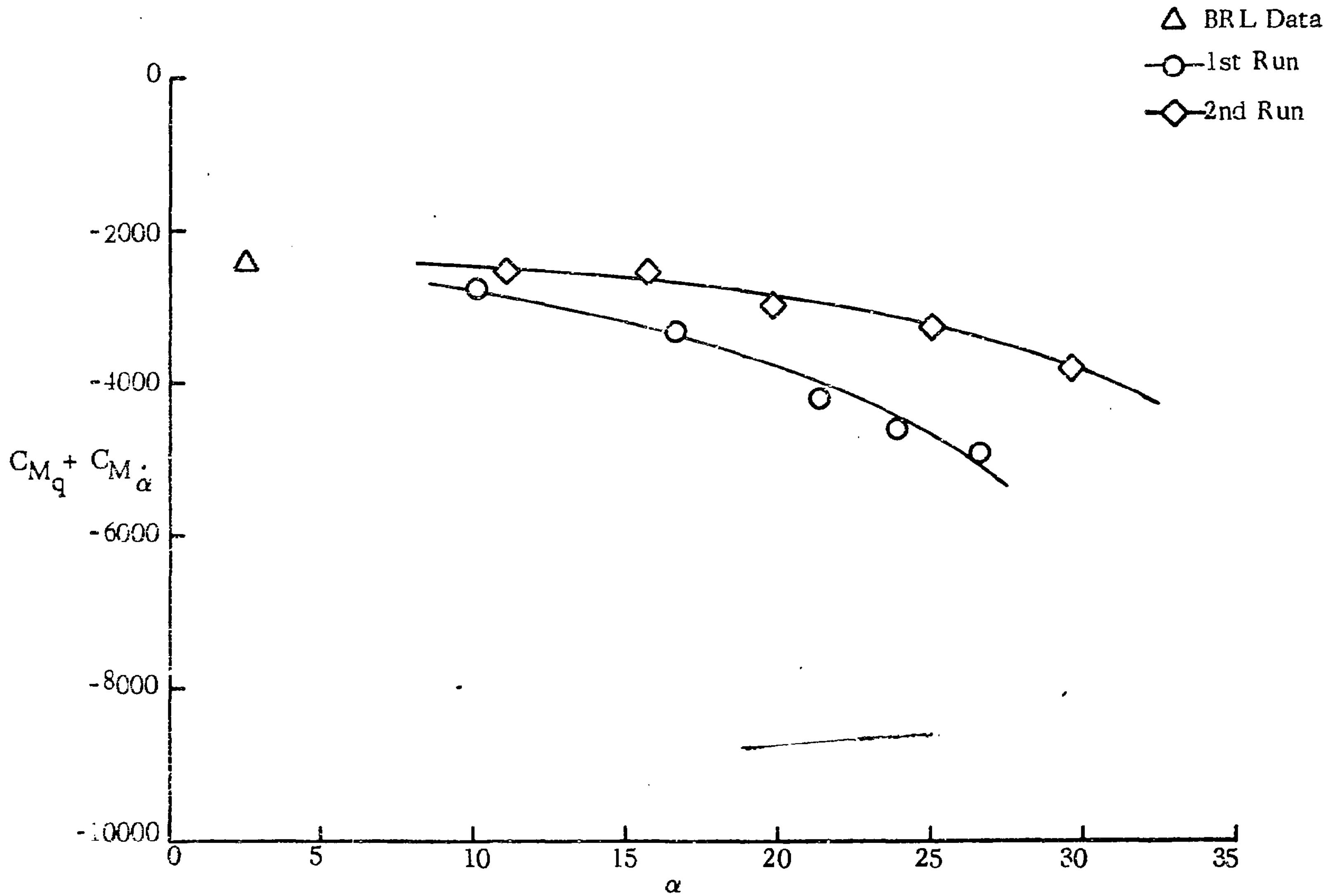


Figure 42. $C_{M_q} + C_{M_{\dot{\alpha}}}$ vs α (Tracer)

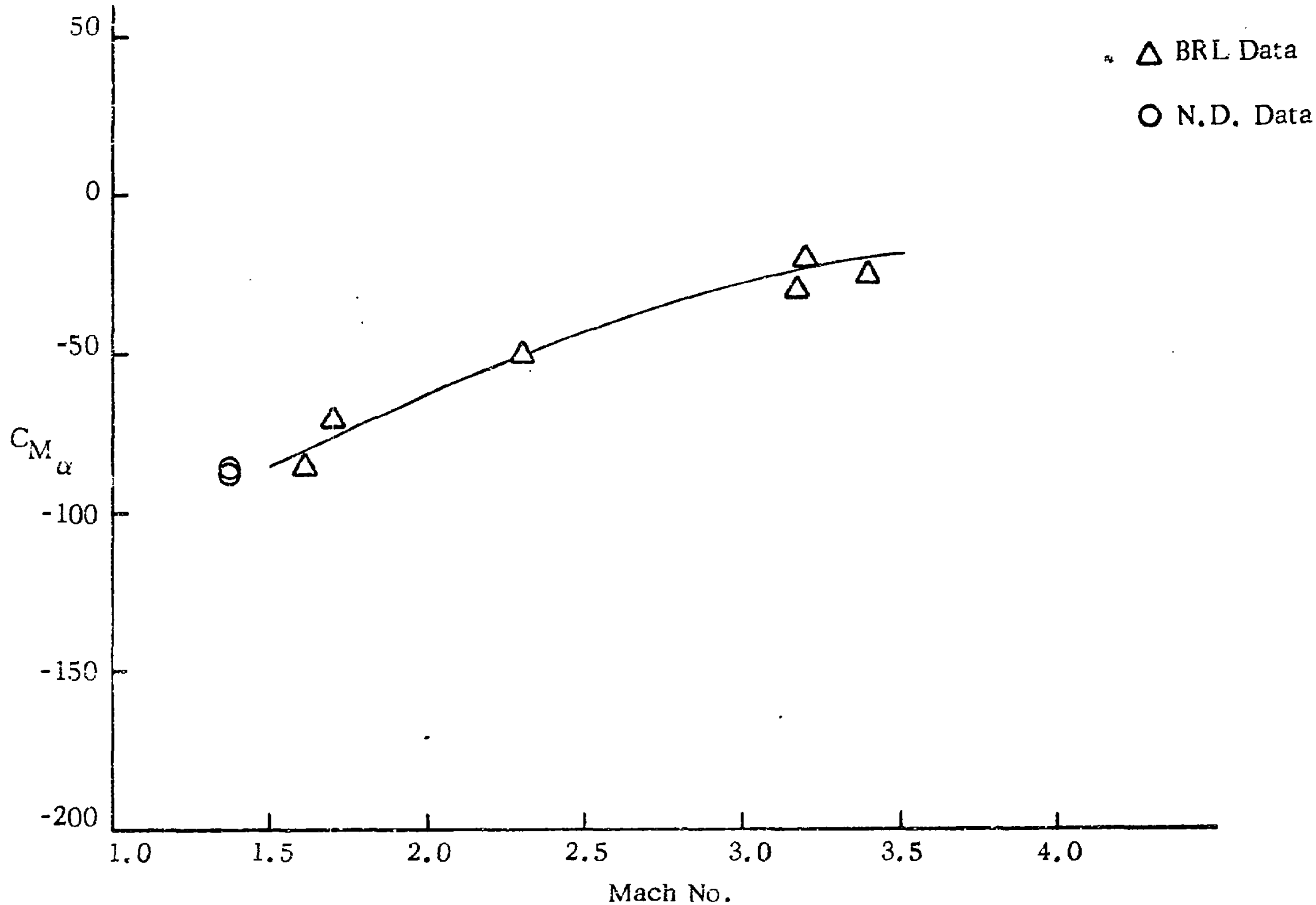


Figure 43. C_{M_α} vs Mach No. (Olin)

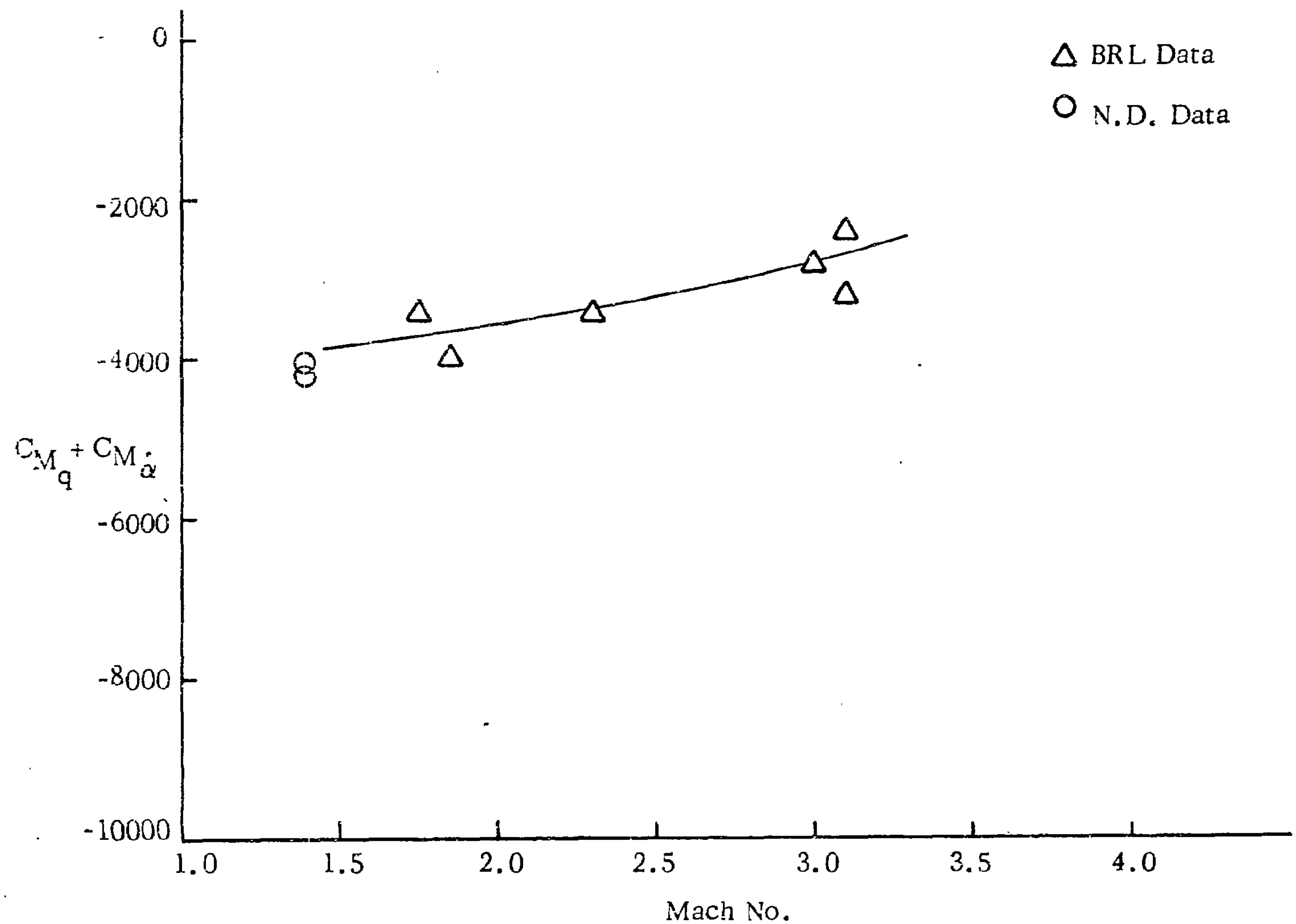


Figure 44. $(C_{M_q} + C_{M_{\dot{\alpha}}})$ vs Mach No. (Ground Point)

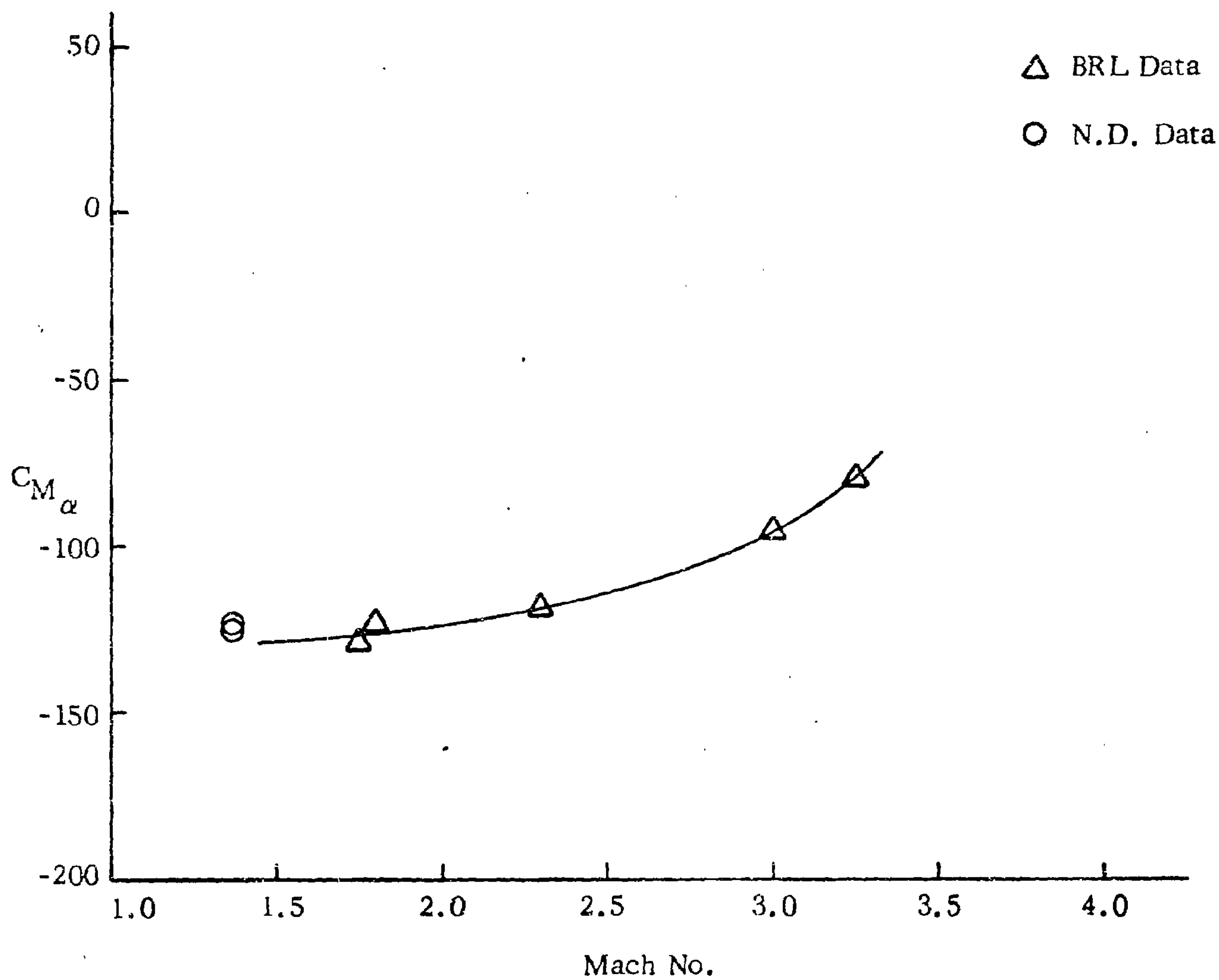


Figure 45. C_{M_α} vs Mach No. (Ground Point)

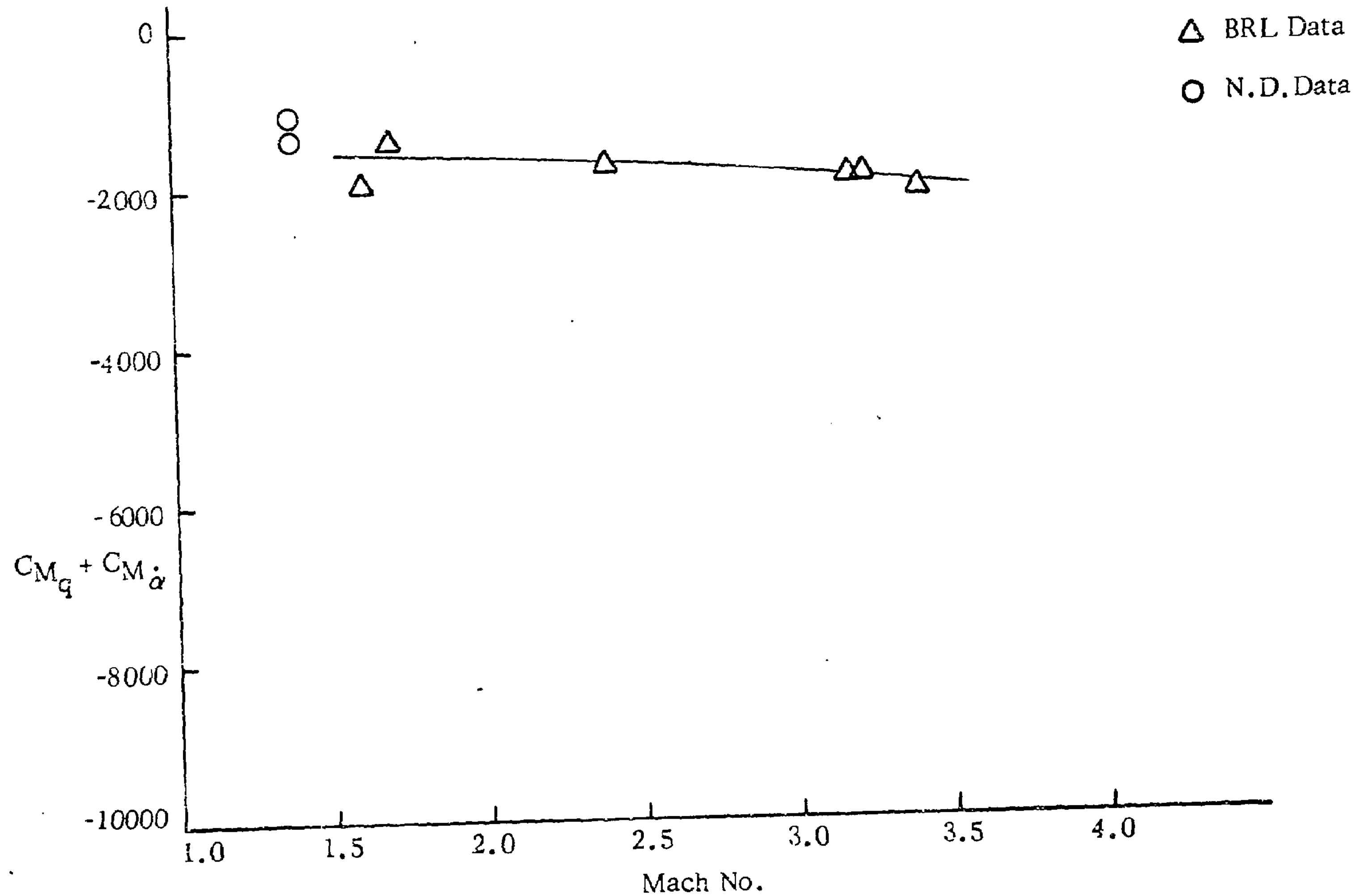


Figure 46. $C_{M_q} + C_{M_{\dot{\alpha}}}$ vs Mach No. (Olin)

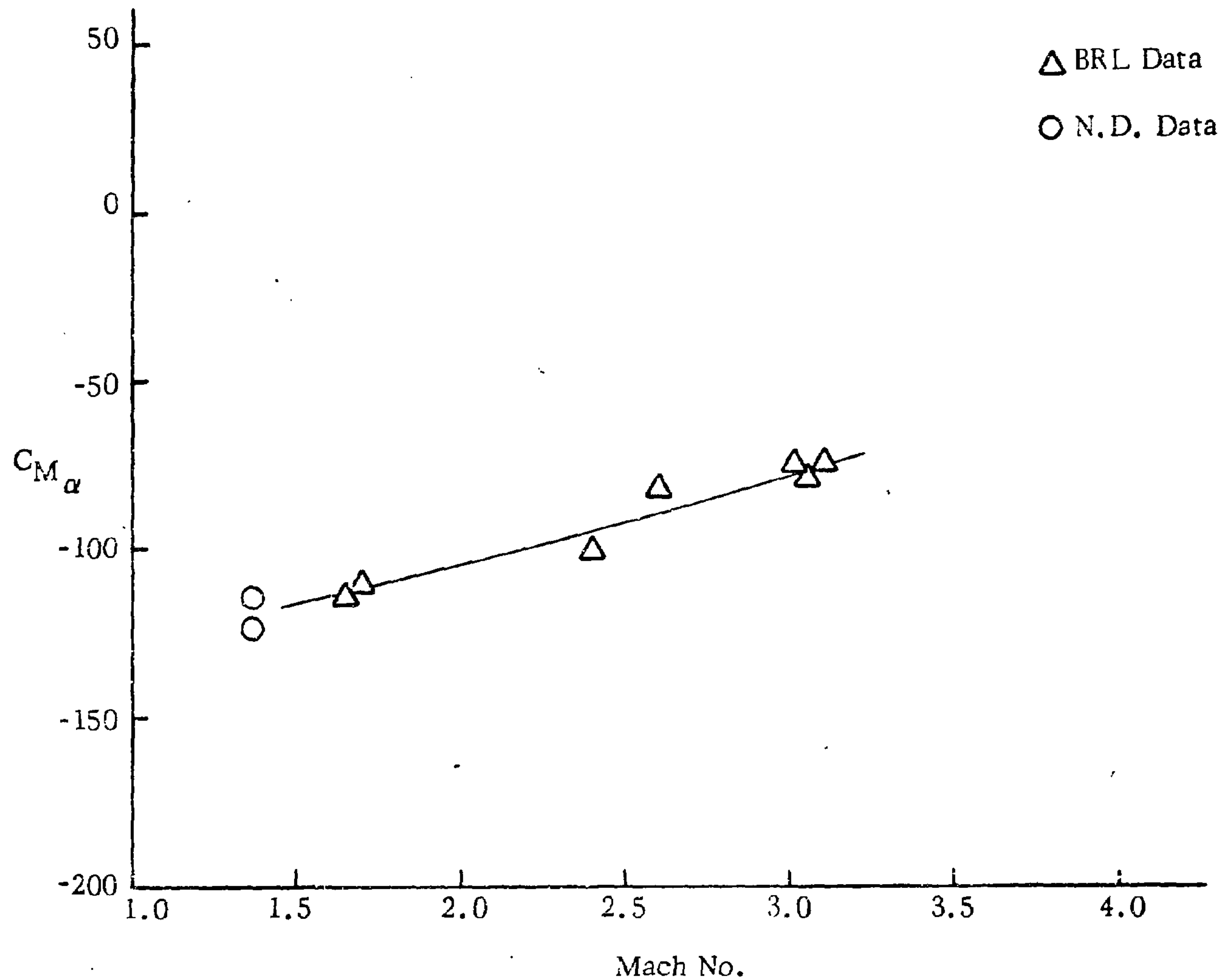


Figure 47. C_{M_α} vs Mach No. (Swaged Point)

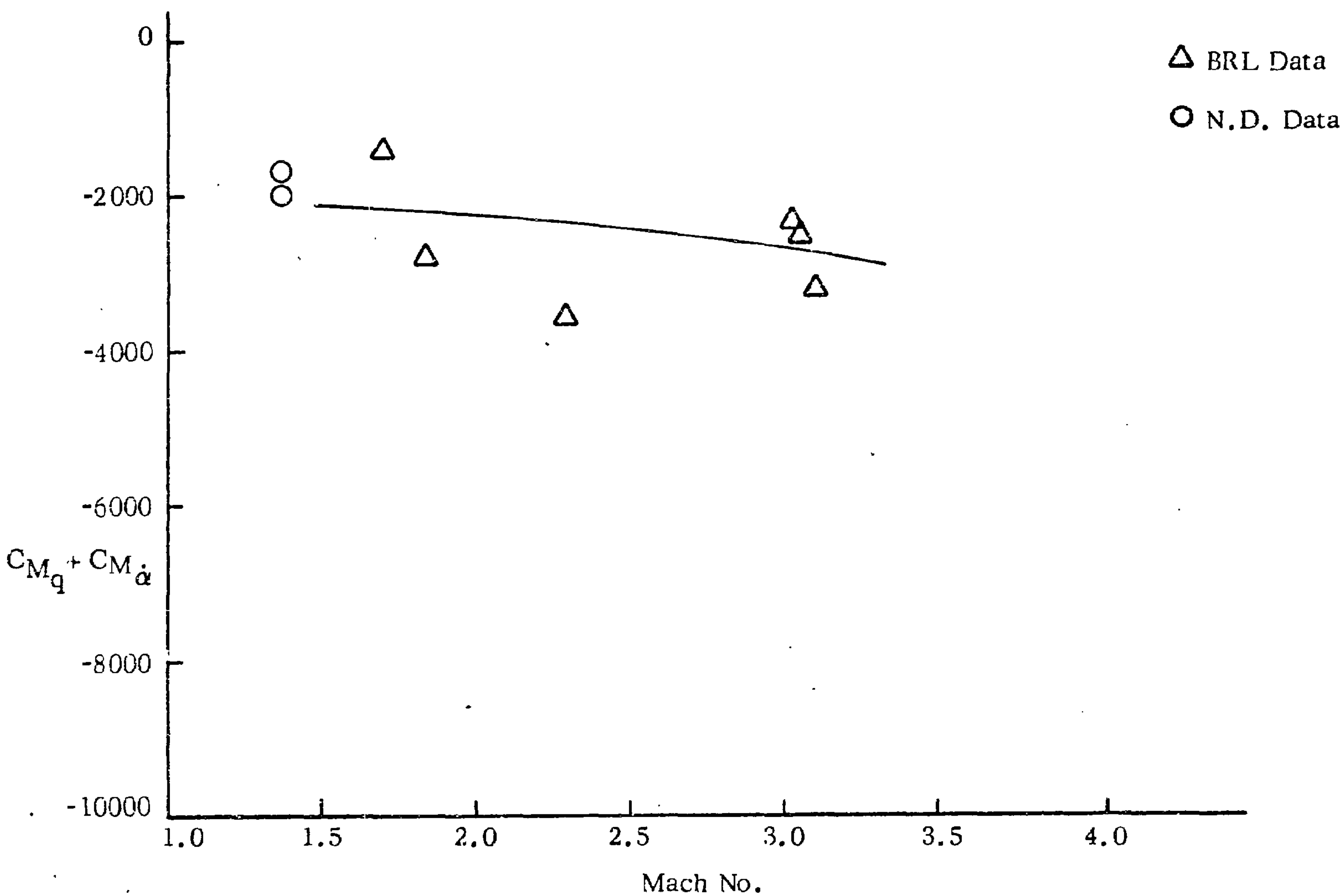


Figure 48. $(C_{M_q} + C_{M_{\dot{\alpha}}})$ vs Mach No. (Swaged Point)

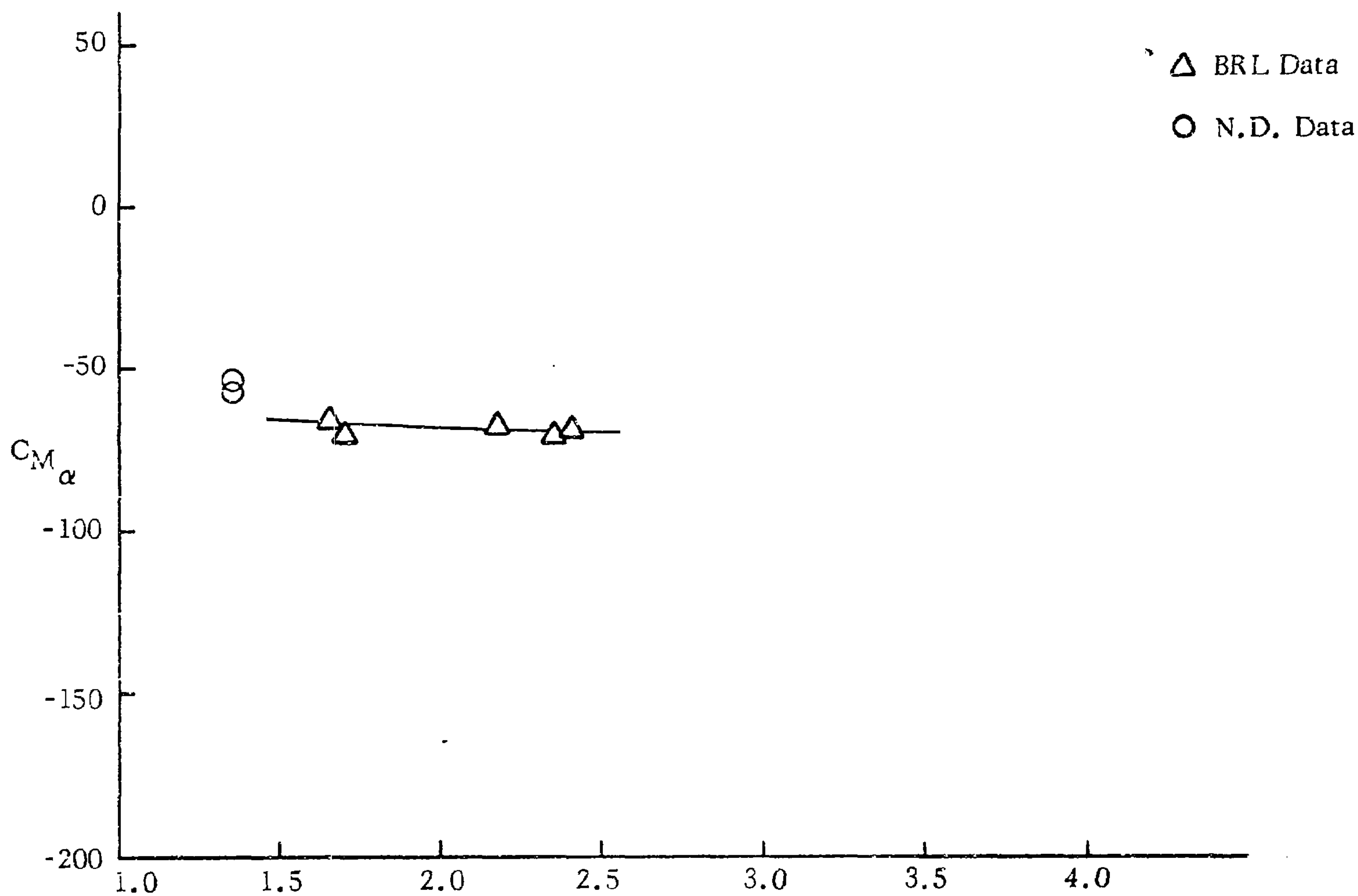


Figure 49. C_{M_α} vs Mach No. (Tracer)

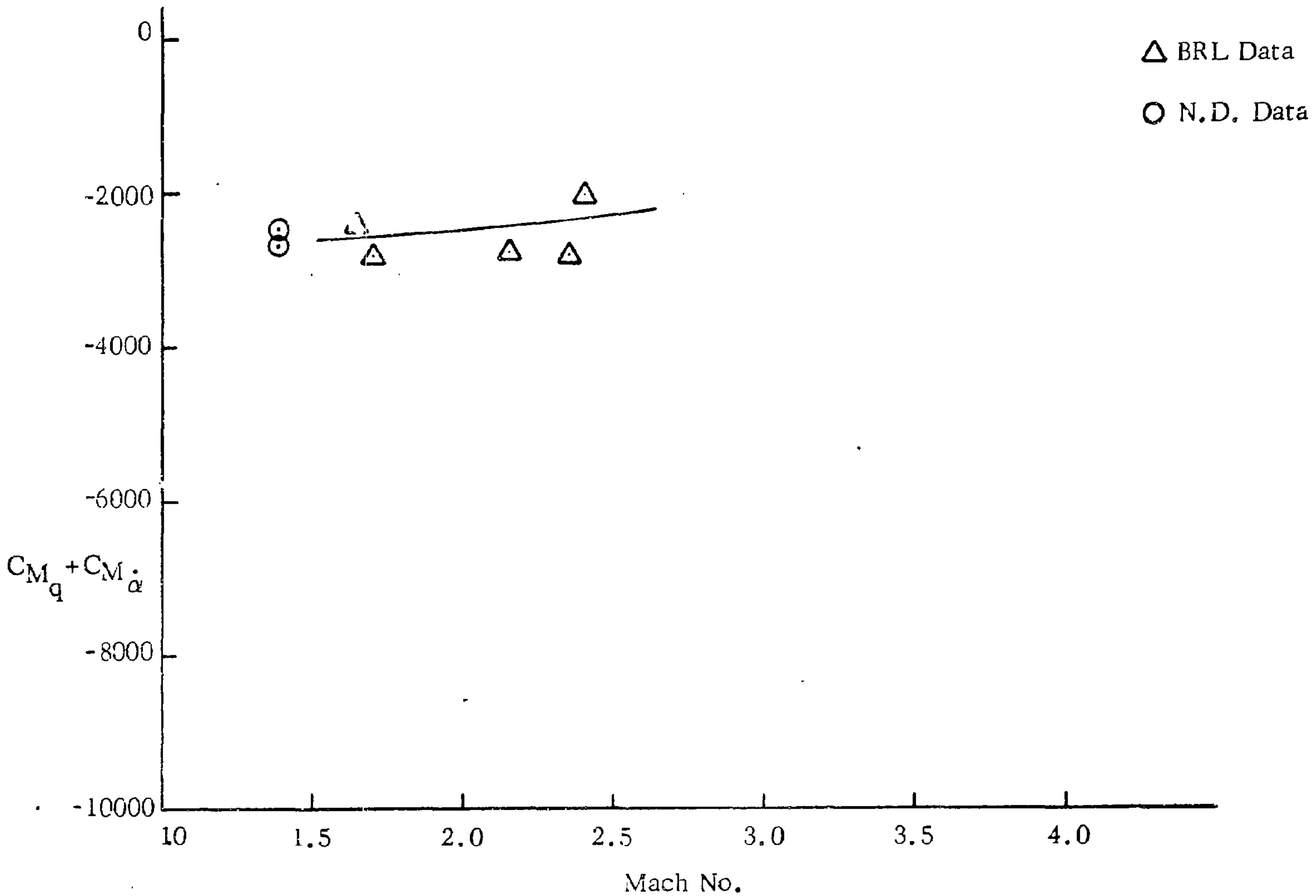


Figure 50. $(C_{M_q} + C_{M_{\dot{\alpha}}})$ vs Mach No. (Tracer)

CONCLUSIONS

Single-degree-of-freedom dynamic supersonic wind tunnel tests of four flechette configurations has been presented. Linear values of C_{M_α} and $(C_{M_q} + C_{M_{\dot{\alpha}}})$ were determined from stability parameters acquired from the data taken during the tests. These values of $C_{M_{\dot{\alpha}}}$ and $C_{M_q} + C_{M_{\dot{\alpha}}}$ showed good repeatability and were compared to results from the Ballistics Range Laboratory (BRL) for the same designs at low angles of attack. Over the range of comparison the agreement between the two sets of data was shown to be quite good.

The repeatability of the results was a good indication of the absence of frictional effects and interference effects to the flow which might have been caused by the support system. In Reference 7 it was shown that this excellent one-degree-of-freedom dynamic testing technique can be easily extended to include the determination of nonlinear values of the static pitching and damping stability coefficients. Also, because the model is suspended at its center of gravity, there is no reason why this technique could not be moved into a horizontal supersonic wind tunnel if necessary.

APPENDIX A

MODEL PARAMETERS

<u>Grount Point</u>

Diameter = .012 ft.
I_y = .000004647 slugs-ft^2
Mass = .0003647 slugs
Radius = 1.69 in.

<u>Olin</u>

Diameter = .0119 ft.
Mass = .000303 slugs
I_y = .000007040 slug-ft^2
Radius = 1.52 in.

<u>Tracer</u>

Diameter = .01533 ft.
Mass = .0004520 slugs
I_y = .0000105570 slugs-ft^2
Radius = 2.11 in.

<u>Swaged Point</u>

Diameter = .012 ft
Mass = .0003933 slugs
I_y = .000006041 slugs-ft^2
Radius = 1.69 in.

APPENDIX B

SUPERSONIC WIND TUNNEL OPERATING PROCEDURE

Starting Procedure

1. Open valve to compressor manifold for wind tunnel to be used - make sure that the other wind tunnels are either shut off or blocked from the manifold.

2. Inform University Power Plant of intention to run compressors.

3. Turn cooling water on (one valve near wall inside laboratory).

4. Turn each compressor shaft to make sure they are free to rotate.

5. Check oil level for each compressor (oil level should be above gear).

6. Check oil pump for each compressor i.e. depress six plungers and observe oil bubbles.

7. Add a few squirts of No. 51 oil to hole in top of shaft bushing.

8. Check mercury manometer tubing in compressor room to make sure it is connected.

9. Turn master power switch on for each compressor.

10. Start one compressor - allow at least one minute after compressor comes up to speed before starting the second compressor and allow another one minute after this compressor comes up to speed before starting third compressor.

11. If mercury manometer reads more than 18 inches, Shut Down Immediately.

Shut Down Procedure

1. Shut compressors off one at a time at one minute intervals.

2. Turn master power switch off for each compressor.

3. Shut compressor cooling water off.

4. Inform University Power Plant that compressors have been shut off.

APPENDIX C

ONE-DEGREE-OF-FREEDOM TEST RESULTS ON R&D FLECHETTES

The model* was initially disturbed to an angle of attack of approximately 180° and then allowed to oscillate freely. The resulting angular motions were then recorded by a high speed camera technique.

One-Degree-of-Freedom Data Reduction

The "Wobble" computer program was used to fit the one-degree-of-freedom Aeroballistic Theory to the angular oscillations obtained from the moving camera technique. This data was fitted in segments of 2.2 cycles with each segment containing approximately 25 points. The stability parameters K_1, K_T, λ_1, ω_1, were determined by the Wobble program at a time interval of 0.015 seconds. The average percent error of the theory to the data showed an error of less than 3%. A representative plot of probable error of fit vs time is shown in Fig. 1a.

The stability parameters were obtained from the fits as functions of time, representative angular oscillations, probable errors of fit, and stability parameters are presented in Figs. 2 through 6. The resulting stability coefficients versus time are presented in Figs. 7 and 8.

One-Degree-of-Freedom Nonlinear Stability Coefficients

To get an indication of the nonlinearity of the stability coefficients

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*Figure 1.

(All dimensions in inches)

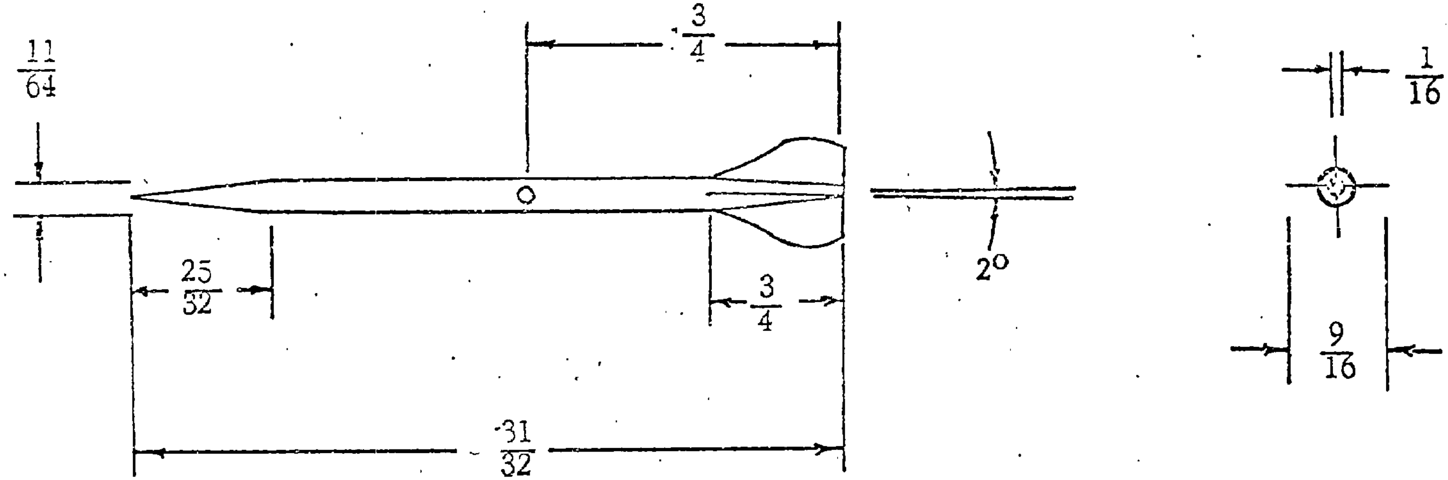

Figure 1. Schematic 1-D Pitch Model

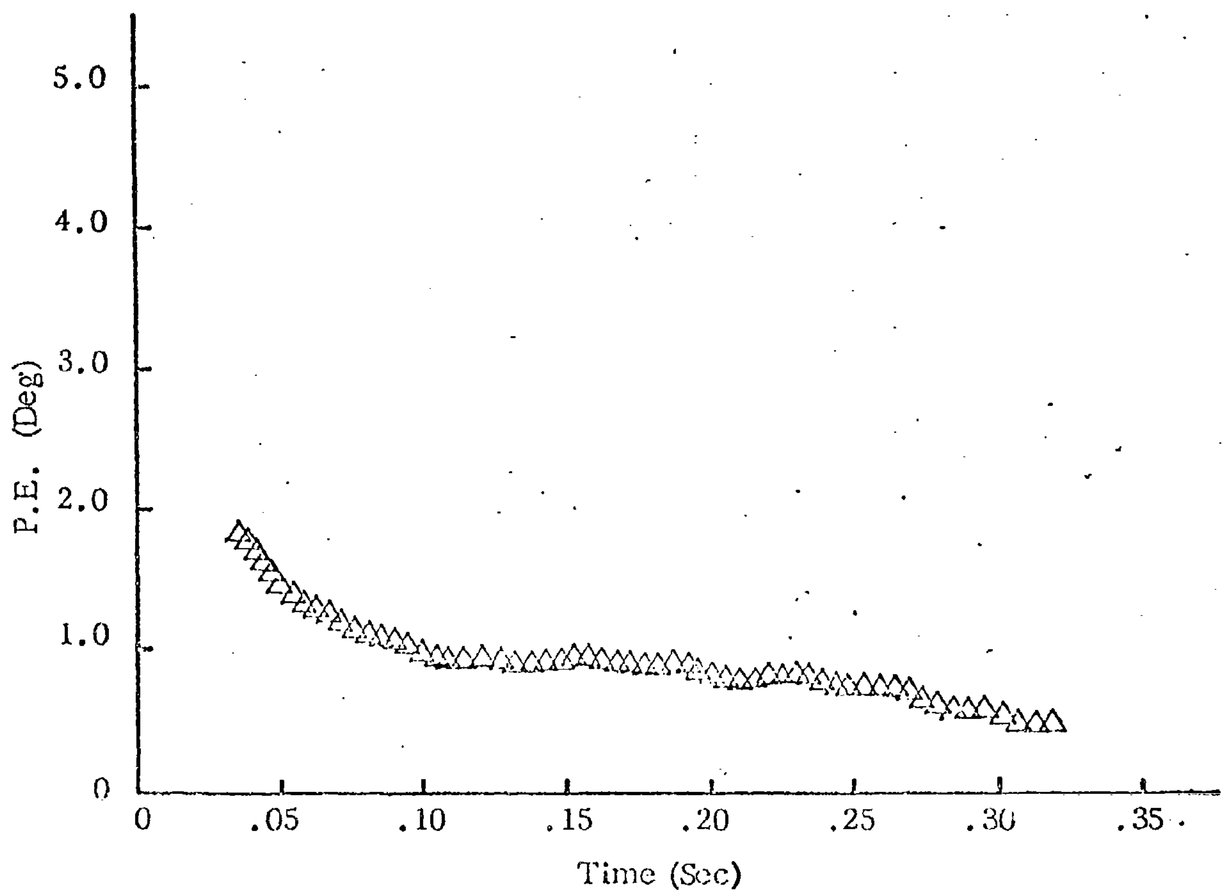

Figure 1a. Probable Error of Fit vs Time

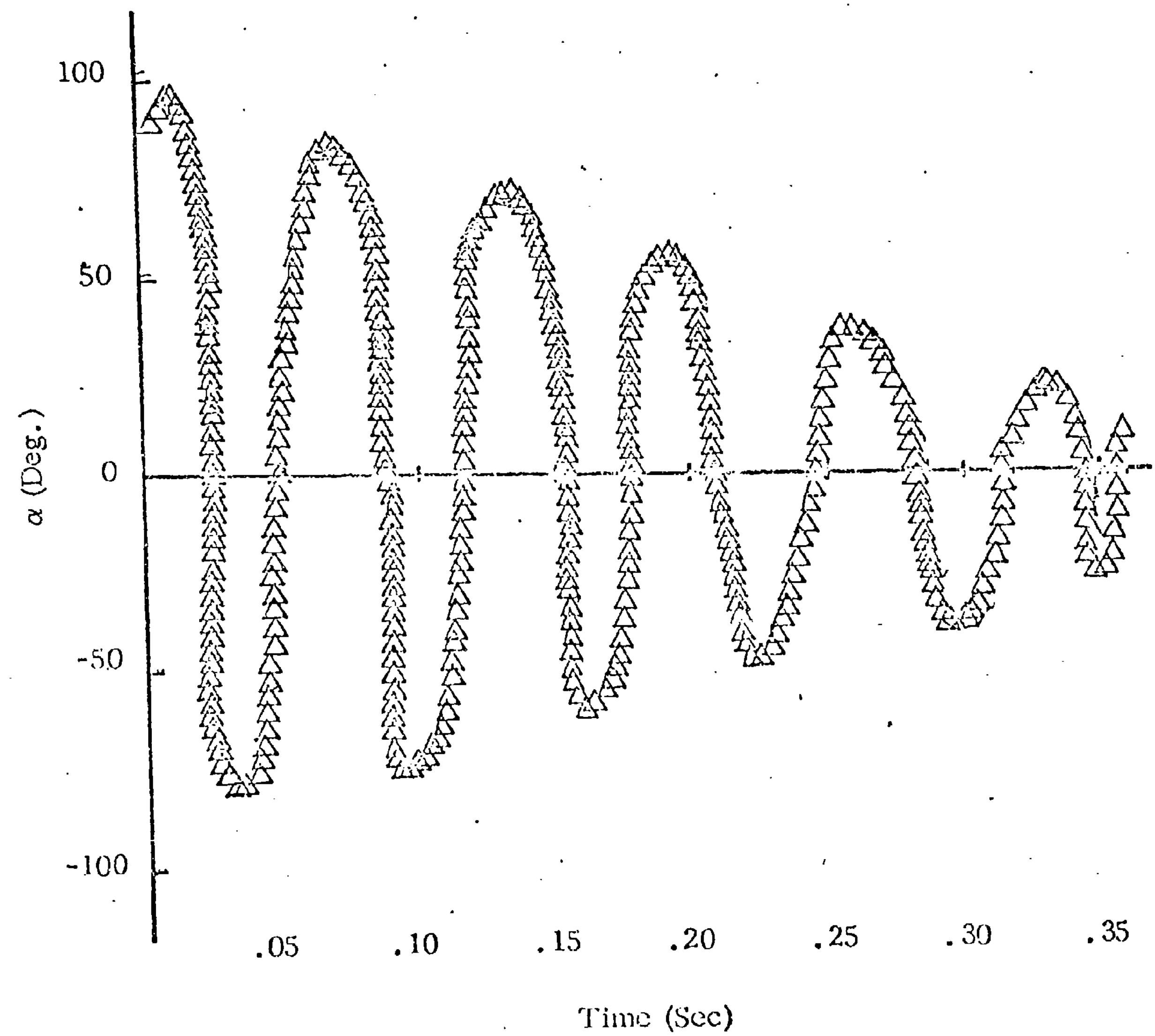

Figure 2. 1-D Oscillatory Motion

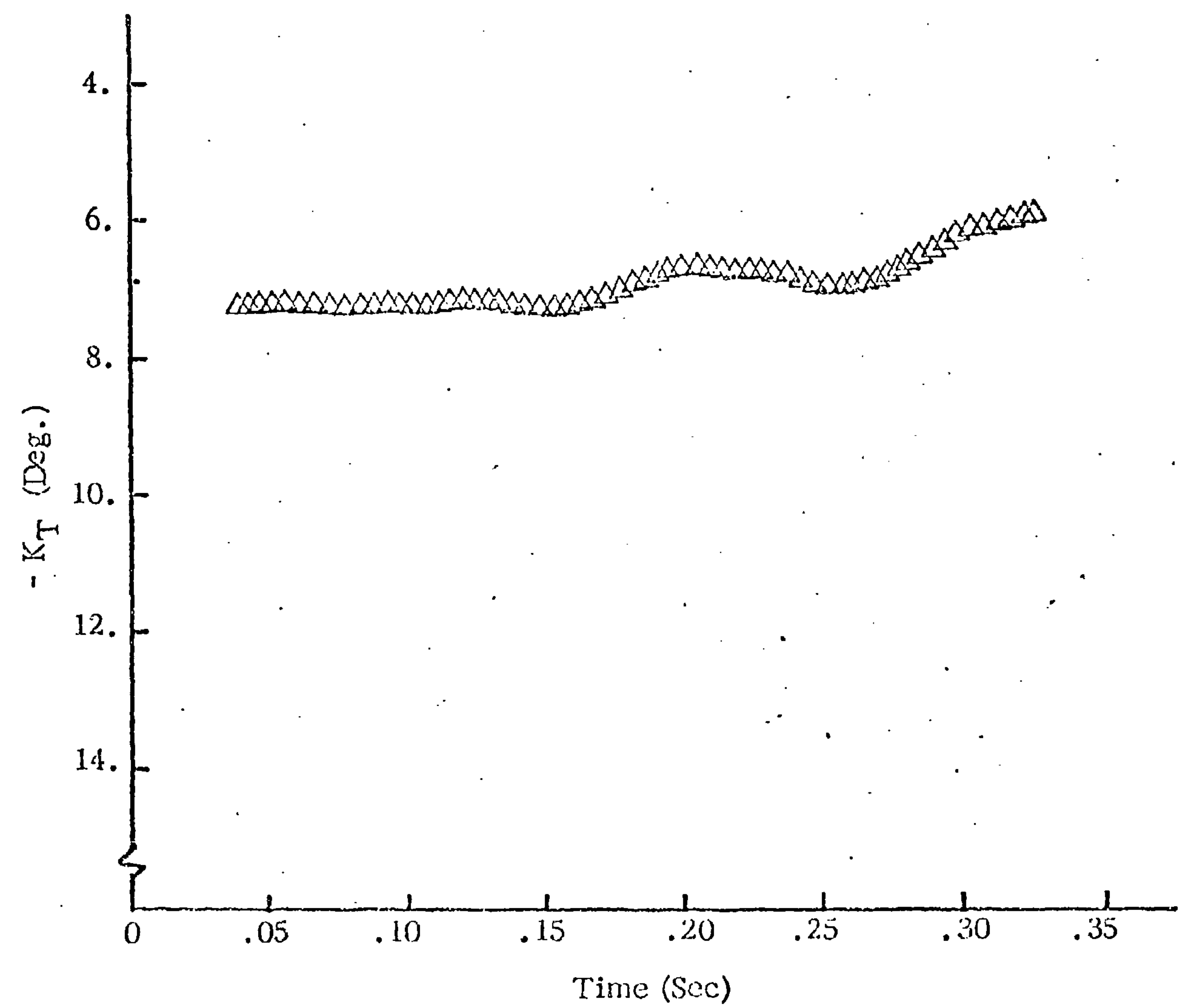

Figure 3. Trim Mode vs Time

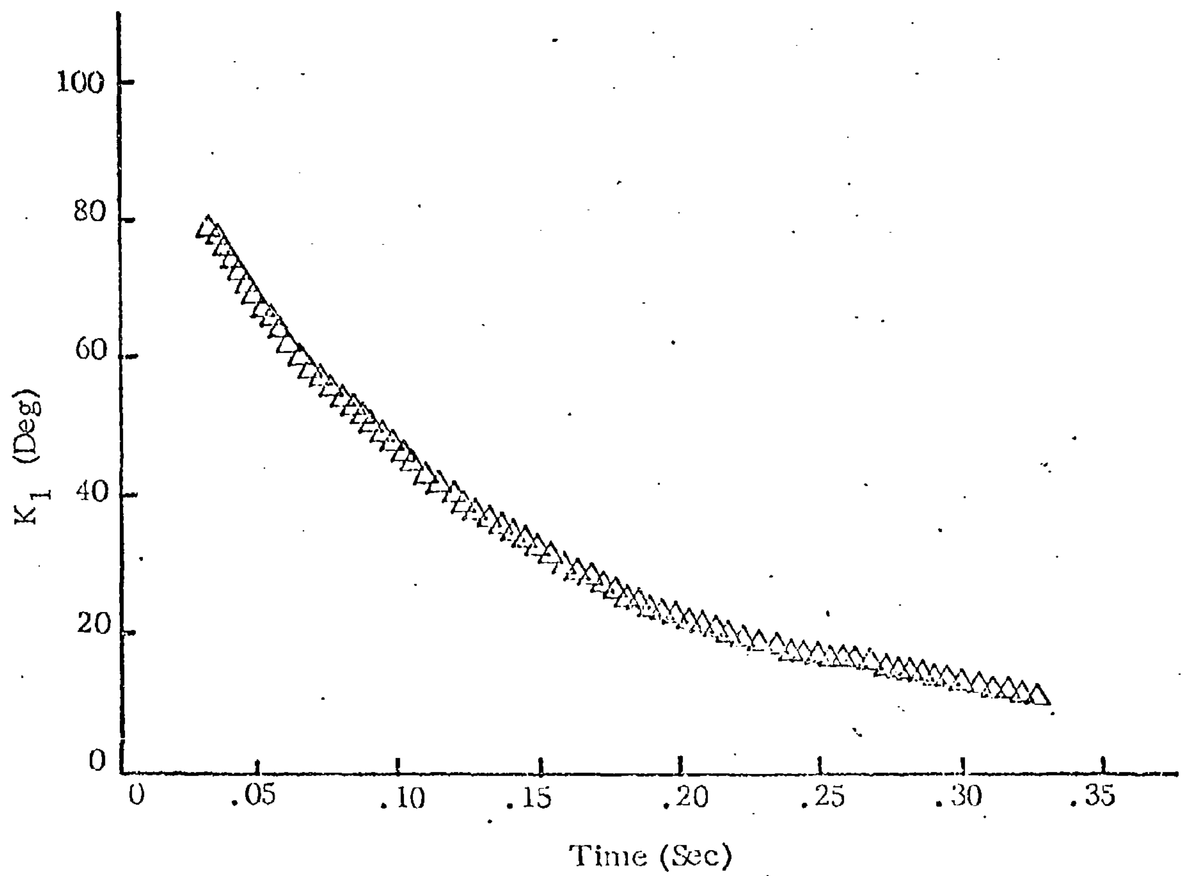

Figure 4. K_1 vs Time

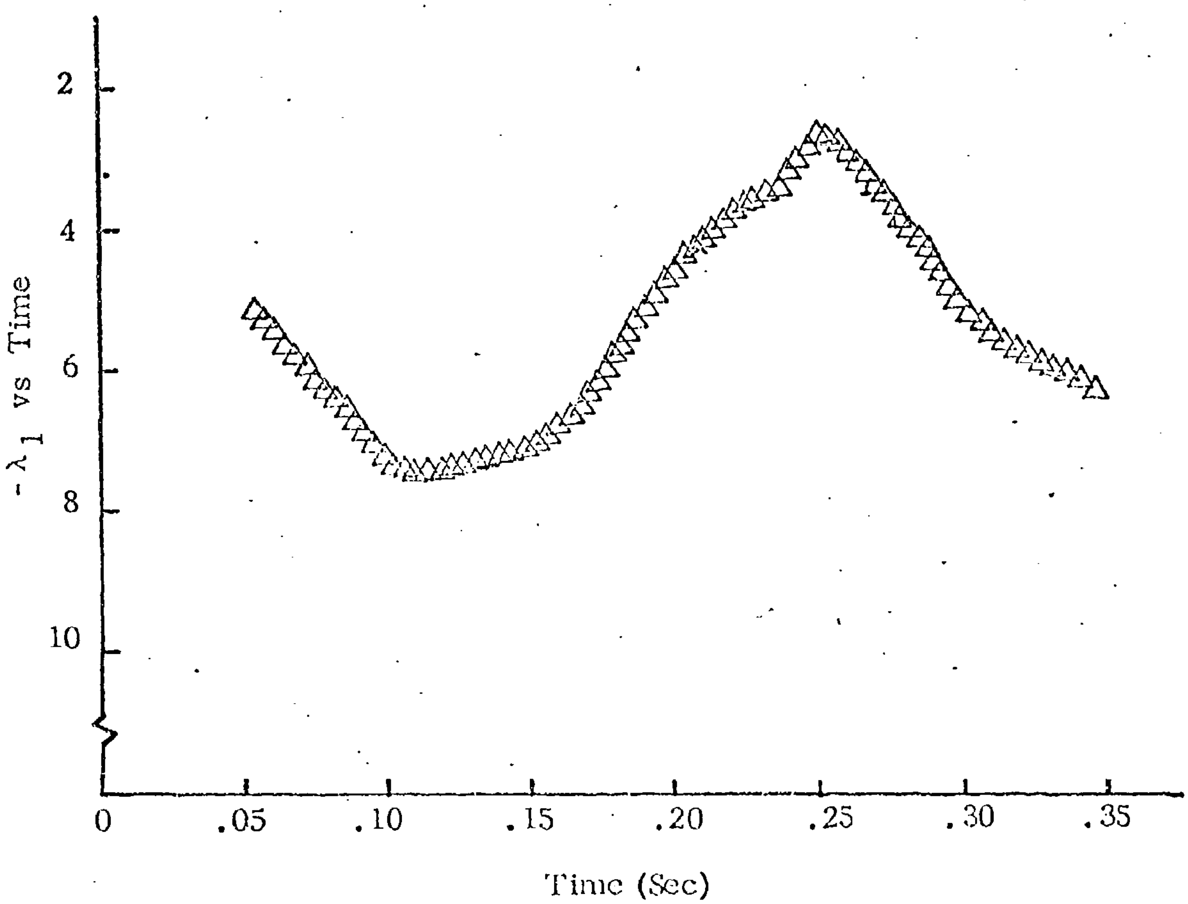

Figure 5. λ_1 vs Time

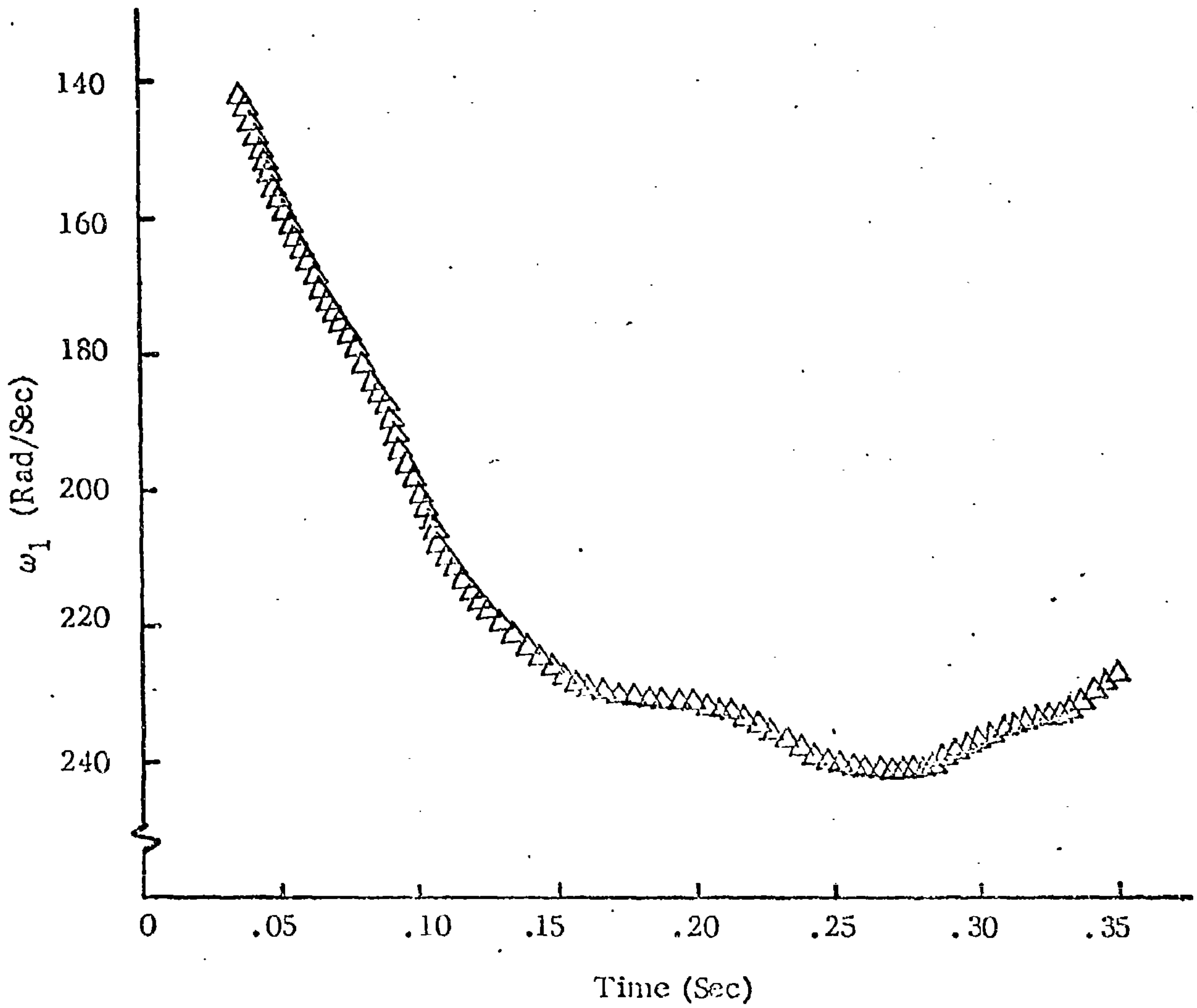

Figure 6. ω_1 vs Time

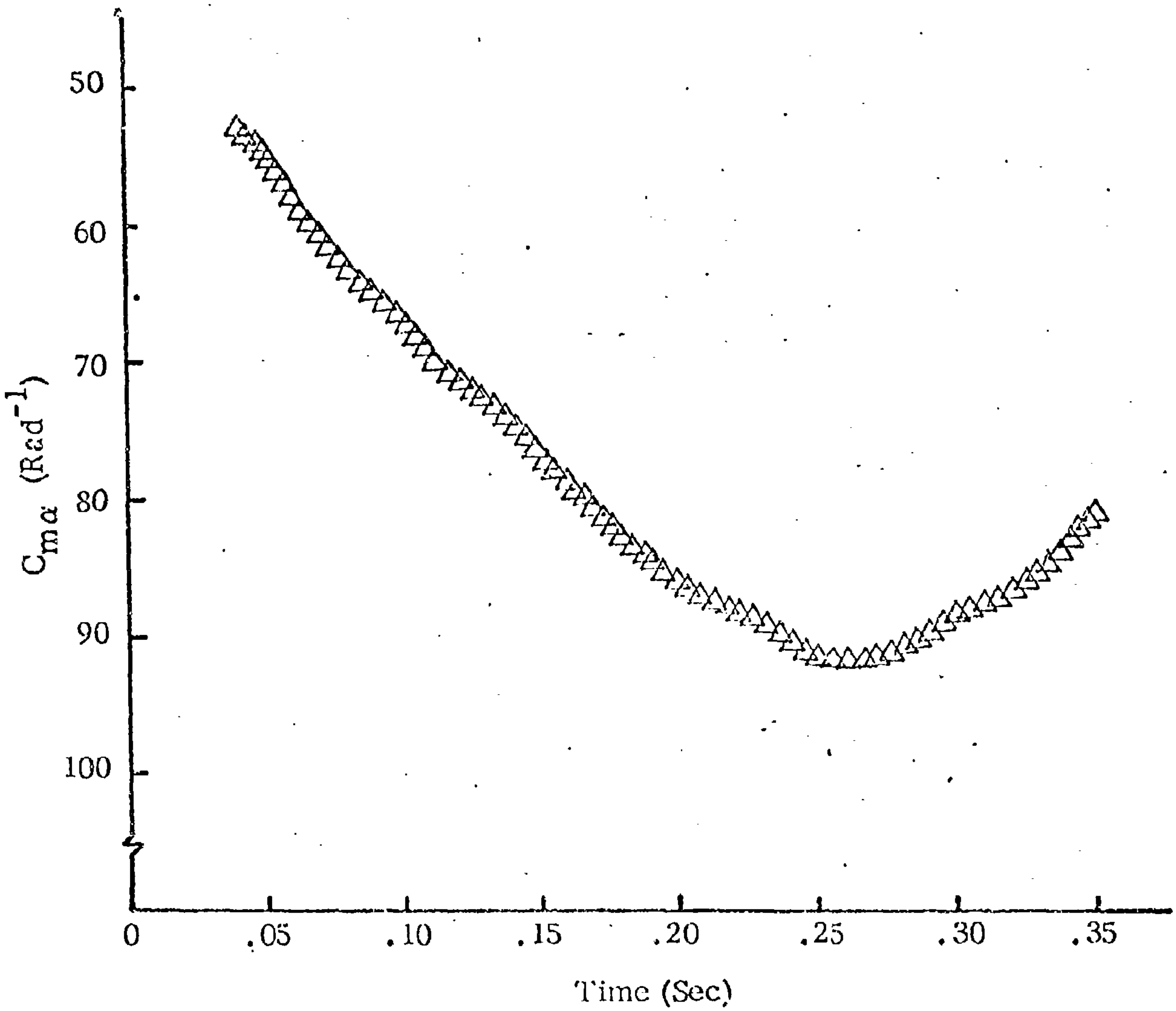

Figure 7. $C_{m\alpha}$ vs Time

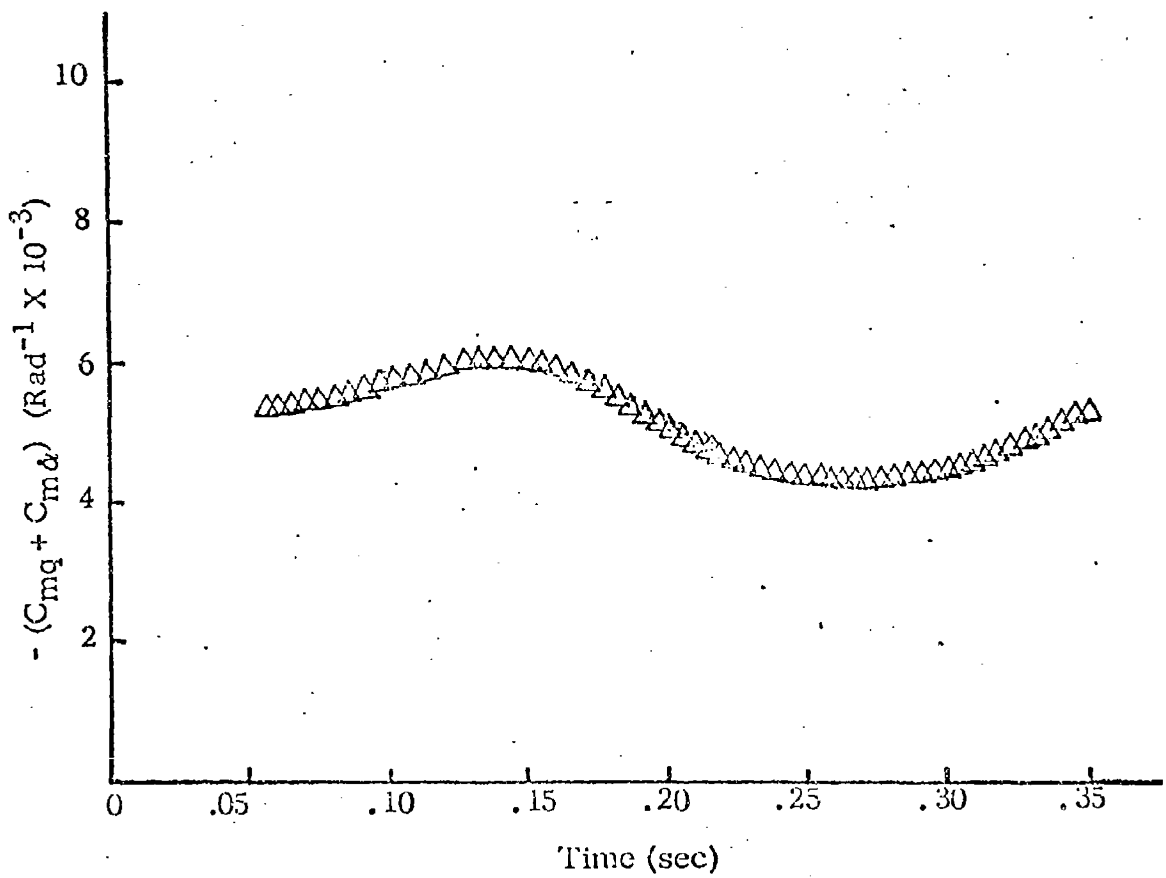

Figure 8. $(C_{mq} + C_{m\dot{\alpha}})$ vs Time

$$C_{m\alpha}(\alpha) = C_{m\alpha_0} + C_{m\alpha_2}(\alpha)^2$$

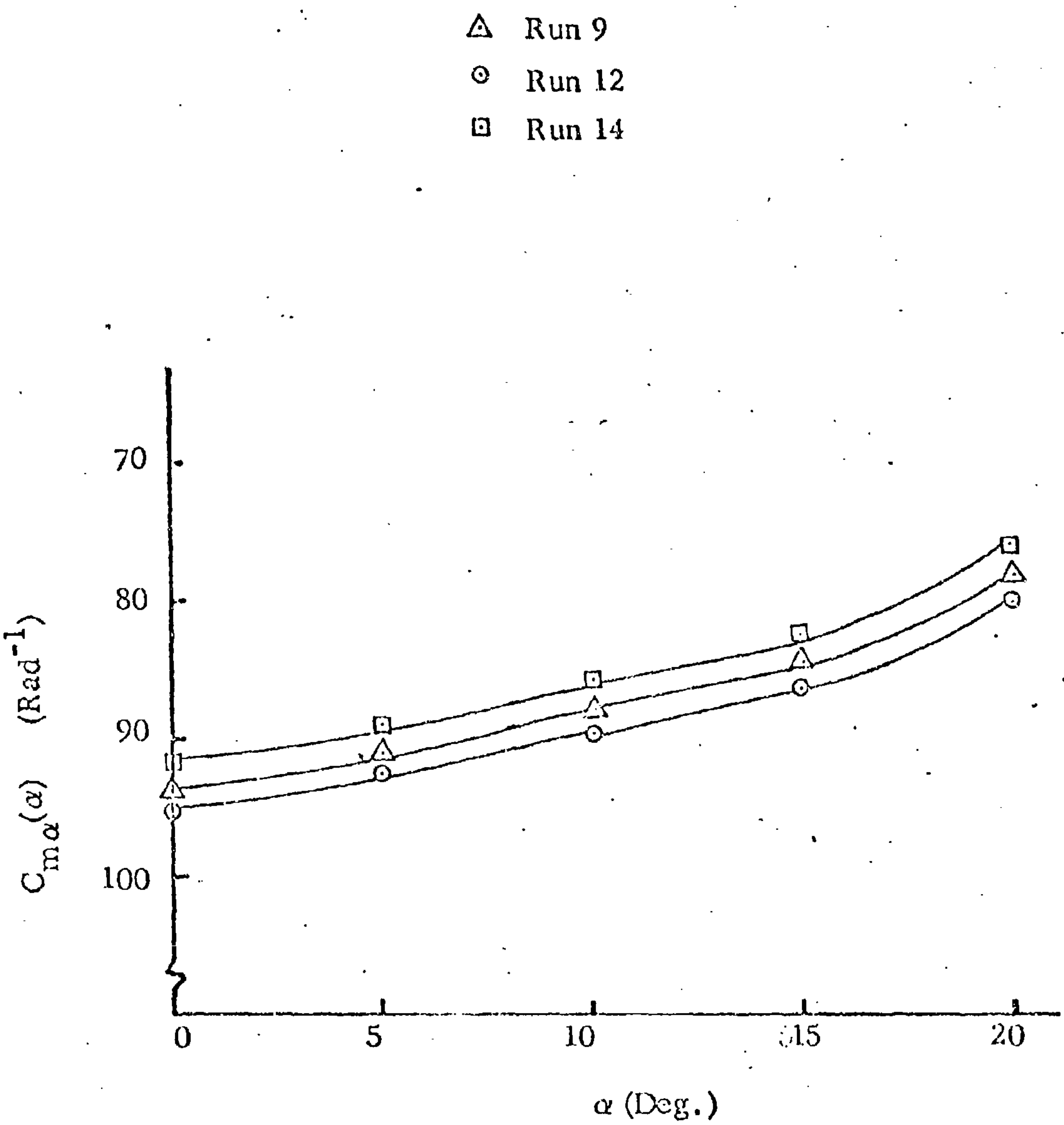

Figure 9. $C_{m\alpha}$ (α) vs α

$$C_{mq}(\alpha) + C_{m\dot{\alpha}}(\alpha) = (C_{mq} + C_{m\dot{\alpha}})_o + (C_{mq} + C_{m\dot{\alpha}})_2\,(\alpha^2)$$

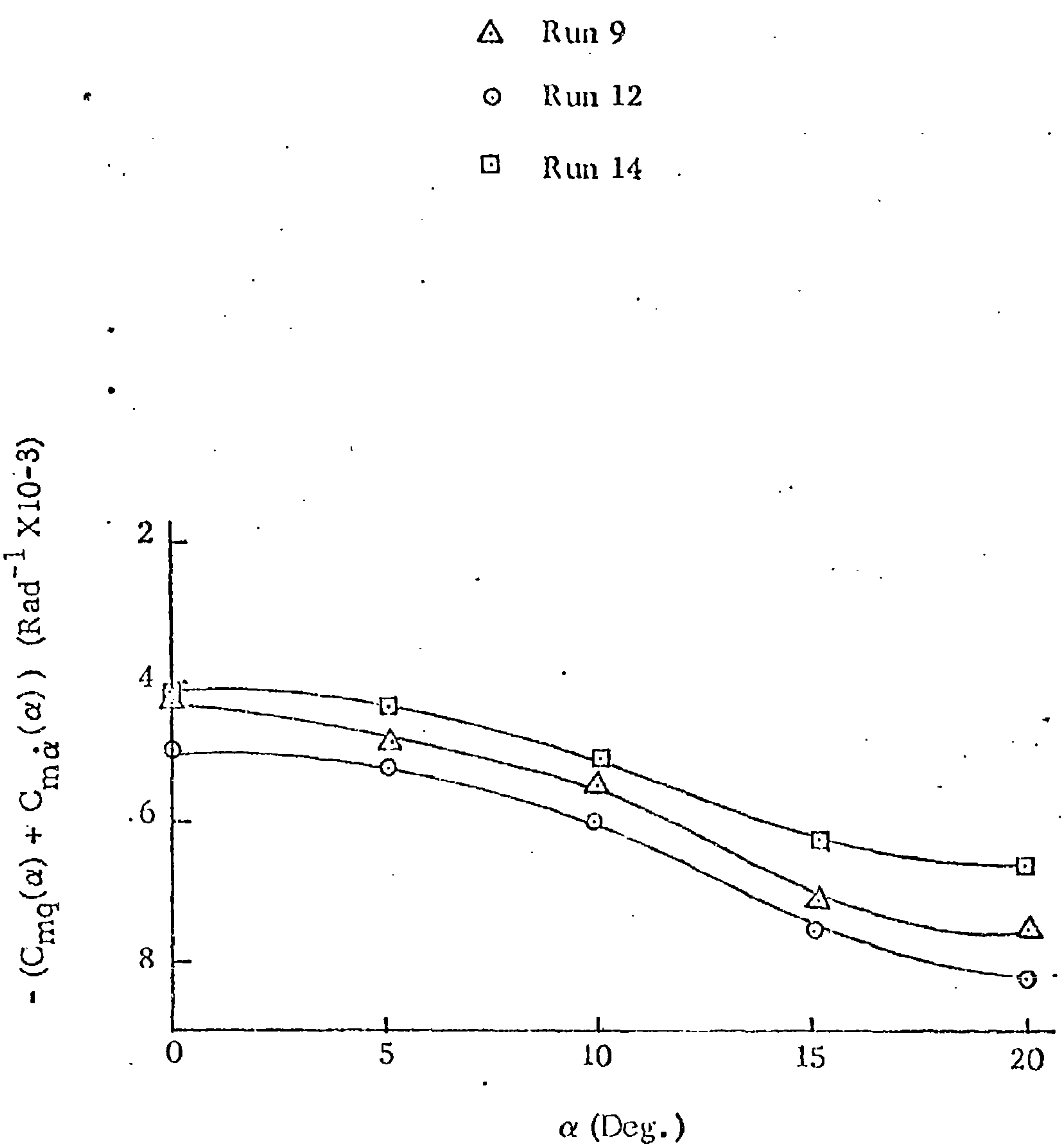

Figure 10. $(C_{mq}(\alpha) + C_{m\dot{\alpha}}(\alpha))$ vs α

with angle of attack, the one-degree-of-freedom Nonlinear Aeroballistic Theory was employed. Using this nonlinear theory, the stability coefficients were determined as polynomial functions of the angle of attack. Representative plots of runs made are presented in Figs. 9 and 10.

Both $C_{m\alpha}$, the pitching moment coefficient and $C_{mq} + C_{m\dot{\alpha}}$ the damping moment coefficient were found to vary nonlinearly with angle of attack. Both were found to be highly repeatable. $C_{m\alpha}$ varied no more than 2% about its mean while $C_{mq} + C_{m\dot{\alpha}}$ varied less than 5% about its mean.

APPENDIX C

DISPERSION THEORY OF HIGH FINENESS RATIO, CRUCIFORM FIN BODIES *

A complete Jump and Dispersion Theory is developed for free flight vehicles. Six-degree-of-freedom computer computations indicates that the theory accurately predicts the jump and dispersion of flechettes.

The initial conditions and dispersion values are established by range test firings. The raw data is fitted by least squares method and put into initial condition form. Initial conditions are applied to the theory and 6-D numerical computations to evaluate dispersion for eight test rounds. The results are compared to test firing target data. The agreement between the theory and test results indicate the data analysis and theory provide an accurate means of predicting dispersion of flechettes. Analysis of the firing data indicates that the initial conditions result from an impulse imparted to the flechette in the muzzle blast. The transverse impulse imparted to the flechette initially must be equal to the angular impulse to obtain zero dispersion. Other disturbances in the blast region such as sabot separation influence the initial conditions and hence dispersion. First maximum yaw theory is discussed and disproved.

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*Prepared by Lawrence E. Lijewski.

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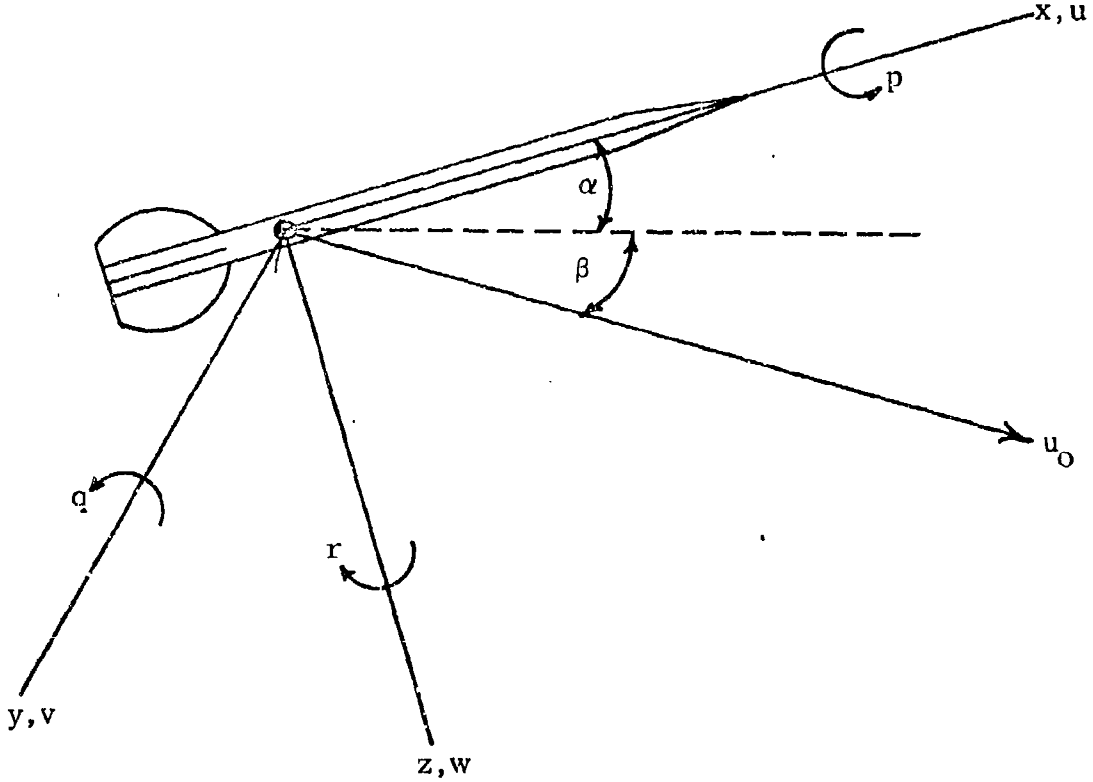
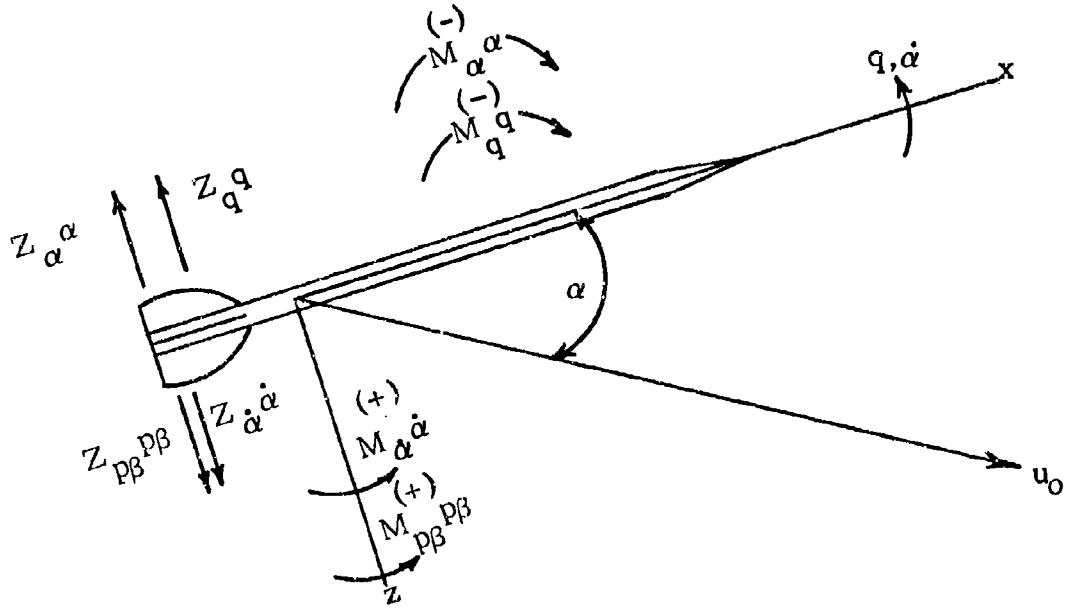
LIST OF SYMBOLS

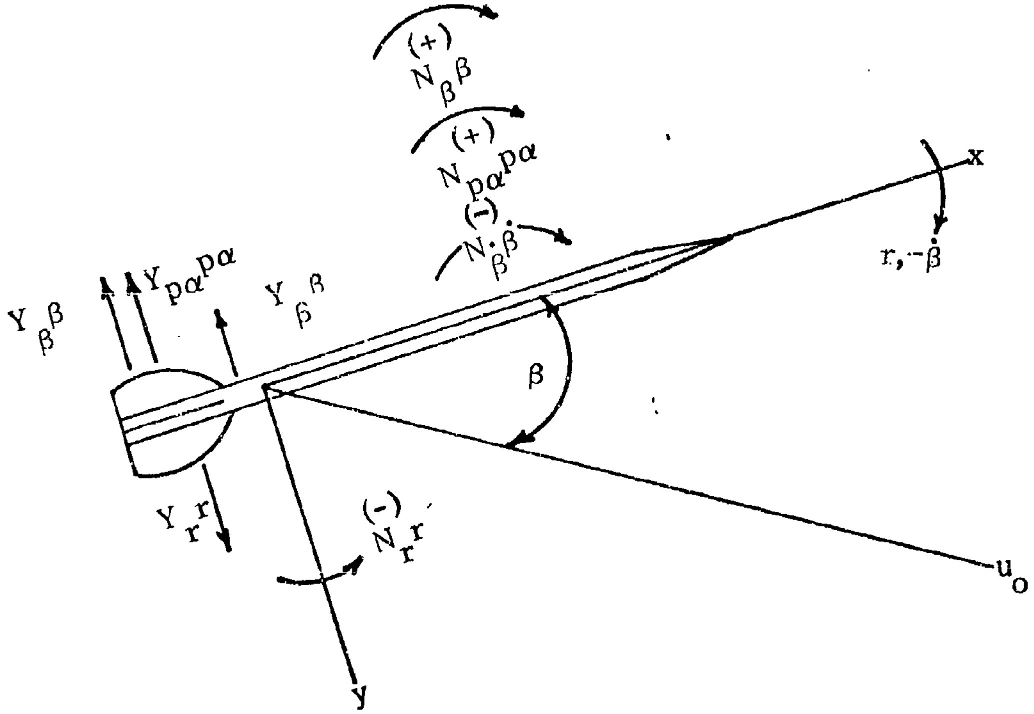
Axis System



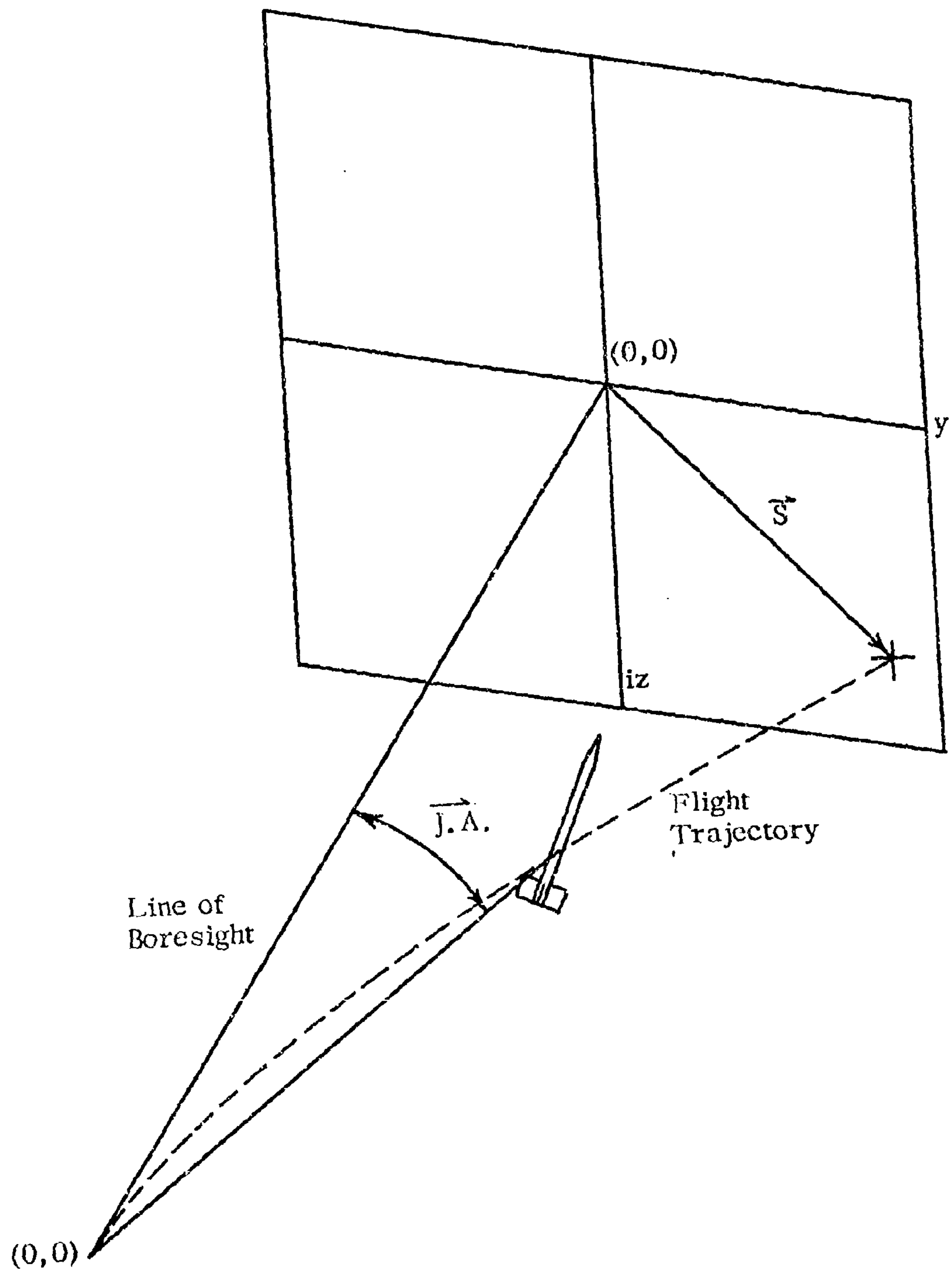
LIST OF SYMBOLS (continued)

Force and Moment Systems





Jump Angle


(0,0)
y
$\vec{S}$
iz
$\overrightarrow{J.A.}$
Flight
Trajectory
Line of
Boresight
(0,0)

$\vec{\alpha}$ complex angle of attack (degrees or radians)

$$\vec{\alpha} = \beta + i\alpha$$

α pitch angle of attack

α_o initial angle of attack

$\vec{\dot{\alpha}}_o$ initial angular rate (rad/sec)

$$\vec{\dot{\alpha}}_o = \dot{\beta}_o + i + \dot{\alpha}_o$$

β yaw angle of attack

C_z pitching force coefficients

$$C_z = \frac{Z}{QS}$$

C_M pitching moment coefficients

$$C_M = \frac{M}{QSd}$$

C_{z_α} static force stability coefficient (rad^{-1})

$$C_{z_\alpha} = \frac{\partial C_z}{\partial \alpha} = \frac{Z_\alpha \alpha}{\alpha QS} = \frac{Y_\beta \beta}{\beta QS}$$

C_{M_α} static moment stability coefficient (rad^{-1})

$$C_{M_\alpha} = \frac{\partial C_M}{\partial \alpha} = \frac{M_\alpha \alpha}{\alpha QSd} = -\frac{N_\beta \beta}{\beta QSd}$$

C_{z_q} damping force stability coefficient (rad^{-1})

$$C_{z_q} = \frac{\partial C_z}{\partial\left(\frac{qd}{2u}\right)} = \frac{Z_q q}{\left(\frac{qd}{2u}\right)QS} = -\frac{Y_r r}{\left(\frac{rd}{2u}\right)QS}$$

$C_{z_{\dot{\alpha}}}$ lag force stability coefficient (rad^{-1})

$$C_{z_{\dot{\alpha}}} = \frac{\partial C_z}{\partial\left(\frac{\dot{\alpha}d}{2u}\right)} = \frac{Z_{\dot{\alpha}}\dot{\alpha}}{\left(\frac{\dot{\alpha}d}{2u}\right) QS} = \frac{Y_{\dot{\beta}}\dot{\beta}}{\left(\frac{\dot{\beta}d}{2u}\right) QS}$$

C_{M_q} damping moment stability coefficient (rad^{-1})

$$C_{M_q} = \frac{\partial C_M}{\partial\left(\frac{qd}{2u}\right)} = \frac{M_q q}{\left(\frac{qd}{2u}\right) QSd} = \frac{N_r r}{\left(\frac{rd}{2u}\right) QSd}$$

$C_{M_{\dot{\alpha}}}$ lag moment stability coefficient (rad^{-1})

$$C_{M_{\dot{\alpha}}} = \frac{\partial C_M}{\partial\left(\frac{\dot{\alpha}d}{2u}\right)} = \frac{M_{\dot{\alpha}}\dot{\alpha}}{\left(\frac{\dot{\alpha}d}{2u}\right) QSd} = -\frac{N_{\dot{\beta}}\dot{\beta}}{\left(\frac{\dot{\beta}d}{2u}\right) QSd}$$

$C_{z_{p\beta}}$ magnus force stability coefficient (rad^{-2})

$$C_{z_{p\beta}} = \frac{\partial C_z}{\partial\beta\,\partial\left(\frac{pd}{2u}\right)} = \frac{Y_{p\alpha}p\alpha}{\left(\frac{pd}{2u}\right)\alpha QS} = \frac{Z_{p\beta}p\beta}{\left(\frac{pd}{2u}\right)\beta QS}$$

$C_{M_{p\beta}}$ magnus moment stability coefficient (rad^{-2})

$$C_{M_{p\beta}} = \frac{\partial C_M}{\partial\beta\,\partial\left(\frac{pd}{2u}\right)} = \frac{N_{p\alpha}p\alpha}{\left(\frac{pd}{2u}\right)\alpha QSd} = \frac{M_{p\beta}p\beta}{\left(\frac{pd}{2u}\right)\beta QSd}$$

$C_{z_{\delta_\epsilon}}\overrightarrow{\delta_\epsilon}$ aerodynamic asymmetry force, total coefficient

$$C_{z_{\delta_\epsilon}}\overrightarrow{\delta_\epsilon} = C_{Y_r}\delta_r + iC_{z_\epsilon}\delta_\epsilon$$

$C_{M_{\delta_\epsilon}}\overrightarrow{\delta_\epsilon}$ aerodynamic asymmetry moment, total coefficient

$$C_{M_{\delta_\epsilon}}\overrightarrow{\delta_\epsilon} = C_{M_{\delta_\epsilon}}\delta_\epsilon + iC_{N_{\delta_r}}\delta_r$$

d	flechette body diameter (ft)
$\vec{\delta_\epsilon}$	complex aerodynamic asymmetry vector
	$\vec{\delta_\epsilon} = \delta_r + i\delta_\epsilon$
δ	phase angle (rad)
g	acceleration due to gravity 32.2 ft/sec^2
γ	rotation angle between α, β axis system and α', β' system to approximate pure pitching motion (deg.)
I_x	axial moment of inertia (slugs-ft^2)
I_y	transverse moment of inertia (slugs-ft^2)
$\vec{J.A.}$	jump angle vector (mils)
$\vec{K_1}$	nutation mode amplitude (deg)
$\vec{K_2}$	precession mode amplitude (deg)
$\vec{K_3}$, k-T	trim mode amplitude (deg)
$\vec{K_4}$	yaw of repose amplitude (deg)
$k_{1,2,3,4,5,6}$	dispersion or jump angle amplitude coefficients
$\lambda_{1,2}; \lambda_{N,P}$	damping factors for nutation and precession modes respectively (rad/sec)
m	mass of flechette (slugs)
p	roll rate (rad/sec)
p_o	initial roll rate (rad/sec)
$\vec{q}$	complex angular velocity (rad/sec)
	$\vec{q} = q + ir$
q	pitching angular velocity (rad/sec)

Q	dynamic pressure $\frac{\text{slugs}}{\text{ft-sec}^2}$
	$Q = \frac{1}{2} \rho u^2$
r	yawing angular velocity (rad/sec)
ρ	density (slugs/ft^3)
S	reference area $S = \frac{\pi d^2}{4}$
$\vec{S}$	complex translation (ft)
	$\vec{S} = y + iz$
$\vec{S}_o$	initial complex translation (ft)
	$\vec{S}_o = y_o + iz_o$
$\dot{\vec{S}}_o$	initial complex velocity (ft/sec)
	$\dot{\vec{S}}_o = \dot{y}_o + i\dot{z}_o$
s	gyroscopic stability factor
τ	dynamic weight factor
t	time (sec)
u	axial velocity (ft/sec)
u_o	initial axial velocity (ft/sec)
v, w	transverse velociries (ft/sec)
$\vec{w}$	complex transverse velocity (ft/sec)
	$\vec{w} = v + iw$

$\omega, \omega_{N,P}$	nutation and precession mode frequencies (rad/sec)
x, y, z	position components

INTRODUCTION

The accuracy and dispersion of free flight vehicles has been a problem in aerodynamics and ballistics for many years. Until the present time, the primary investigations into causes and effects of jump (the angle between the line of boresight and the line connecting the point of launch with the instantaneous position on the trajectory,) and dispersion have been directed toward projectiles and, in particular, artillery rounds. A full program to investigate jump and dispersion characteristics of low trajectory finned bodies has been lacking and therefore is the subject of this dissertation. The purpose of this analysis is to develop a basic understanding of the parameters causing the jump and dispersion of flechettes. The flechette, being a gun launched finned body, requires a different approach to the problem. The old concept employed in the analysis of the dispersion of artillery rounds is that the dispersion results from initial launch disturbances imparted by the gun to the shell.[1,2] This concept is no longer valid for flechettes since the flechette is a fin missile, sabot launched, and its dispersion must be tied to the disturbances it encounters when clearing the muzzle blast and sabot separation region. In addition, asymmetries are more prevalent in finned bodies than projectiles and a finned body is more apt to be influenced by the blast. These factors must be taken into account by a theory involving finned bodies.

In order to develop this new approach, (1) a theoretical expression for jump and dispersion had to be developed, (2) the theory had to be validated, (3) free flight test firings had to be undertaken and initial condition data extracted, and (4) the test firing results had to be correlated with the validated theory. The Jump and Dispersion Theory was developed, in general, for both fin and spin stabilized missiles in air. The theory includes the effects of: initial conditions, Magnus, aerodynamic asymmetries, and gravity. In the past, theory development for projectiles included only initial angle of attack and initial angular rate.[1,3] Initial transverse velocity was considered non-existent[4] or negligible. Zaroodny[5] included a linear momentum term to account for any transverse motion of the projectile but attributed it to the gun during recoil. Any transverse impulse imparted to the projectile by the blast was ignored. Other authors, including Sterne[2] attributed the jump only to bore clearance and therefore only included, effectively, the initial angle of attack. Magnus effects were always neglected in previous studies either due to lack of familiarity with the subject or lack of data. In general, all cross-forces, except lift, were neglected mainly for convenience sake. Zaroodny, however, cautioning against wholesale simplifying said "it would seem desirable that our formulas allow us to include these other forces as the experimental information on these forces becomes available." Aerodynamic asymmetries were neglected for projectiles but included in Murphy's work.[6] It was not until Nicolaides[7,8,9] that all four factors affecting dispersion; initial angle of attack, initial angular rate, initial transverse position and velocity, were put into one theory. The work presented here expands the work of Nicolaides to include all parameters affecting dispersion in detail. Three separate equations comprise the theory to include the complete range of roll rates. Before, only high roll rates were considered; with the study of finned bodies, the roll rate range extends down to zero roll and accurate theories had to be deduced from known aerodynamic equations.

To validate the theory, a six-degree-of-freedom trajectory computer program numerically integrating the equations of motion was utilized.[10, 11, 12] The validation consisted of four phases. The procedure began with the most basic theory equation and consecutively added terms to validate the entire theory. Initial conditions, magnus, asymmetries and gravity were successively validated with roll rate and velocity varied in each phase.

Before the advent of adequate photographic material, obtaining test data was often difficult. At first, jump target data was taken separate from yaw data. The thinking was that the yaw data was part of the projectile's characteristics and not affecting jump. As photographic methods improved, and theories developed, the data was correlated. The correlation of the data was often a problem. A fit of the motion to a least squares method was difficult. Fowler, Kent, and Hitchcock developed a method that would plot the magnitude of the yaw separately from the orientation and then fit the curves separately. A better method was developed by McShane-Charters-Turetsky approximated the yawing motion to a circle. For projectiles the method has been refined and is an excellent method. However, for finned bodies with not always circular angular motions, a different method of data analysis had to be devised. Utilizing the free flight data taken by test engineers at Frankford Arsenal on a number of flechettes, the least squares method was employed to fit the data presented here. The nearly planar oscillations of the flechette in the first few feet downrange were fit to a pure pitching motion[13, 14] and the position downrange fit to a third order polynomial. From these results, angle of attack, angular rate and transverse position and velocity were determined for the first few feet downrange. Before, there was some controversy as to whether or not the least squares fit could be extrapolated back to the muzzle. Zaroodny contended that the $x = 0$ position had to be taken out of the blast region to allow the aerodynamic equations to be valid. On the other hand, Kent, Hitchcock, Fowler and Sterne held to the fact that the free flight region began the instant the projectile left the bore. In the analysis of flechettes the position $x=0$ is taken somewhere downrange after the sabot separation sequence has occurred. This is seen to be 3 to 5 feet downrange and assumed clear of any muzzle blast effects.

The striking shortcoming of previous works is the lack of correlation between test data and valid theory. For the flechette, correlation between the theory and test data was undertaken as well as correlation between test results and first maximum yaw data. Currently, the first maximum yaw theory[15] is held by some to be an accurate method of predicting dispersion. This theory disallows any influence of initial angular rate, transverse position or velocity on dispersion. The dispersion analysis presented here disproves this theory with actual test data. The details of each of these aspects of this program are developed in the following sections.

DISPERSION THEORY

Dispersion relationships for free flight vehicles are embedded in the trajectory equation of any such aeroballistic body. To evaluate the trajectory equation and thus the dispersion, the linear second-order differential equation of angular motion is a logical starting point.

$$\ddot{\vec{w}} + N_1\dot{\vec{w}} + N_2\vec{w} = \vec{N}_3 e^{ipt} + \vec{N}_4 \tag{1}$$

where N_1, N_2, $\vec{N}_3$, and $\vec{N}_4$ are constants.

$$N_1 = \left[\frac{Z_w + ipZ_{pv}}{Z_{\dot{w}} - m}\right] + \frac{M_{\dot{w}}}{I_y}\left[\frac{mu+Z_q}{Z_{\dot{w}} - m}\right] - \left[\frac{ipI_x}{I_y} + \frac{M_q}{I_y}\right] \tag{2}$$

$$N_2 = \left[\frac{M_w + ipM_{pv}}{I_y}\right]\left[\frac{mu+Z_q}{Z_{\dot{w}} - m}\right] - \left[\frac{Z_w + ipZ_{pv}}{Z_{\dot{w}} - m}\right]\left[\frac{ipI_x}{I_y} + \frac{M_q}{I_y}\right] \tag{3}$$

$$\vec{N}_3 = \left[\frac{Z_{\delta_\epsilon}\vec{\delta}_\epsilon}{Z_{\dot{w}} - m}\right]\left[\frac{M_q}{I_y} + \frac{ipI_x}{I_y} - ip\right] - \frac{M_{\delta_\epsilon}\vec{\delta}_\epsilon}{I_y}\left[\frac{mu+Z_q}{Z_{\dot{w}} - m}\right] \tag{4}$$

$$\vec{N}_4 = \frac{img}{I_y}\left[\frac{M_q + ipI_x}{Z_{\dot{w}} - m}\right]. \tag{5}$$

In this discussion of dispersion theory, it is assumed that,

(1) total velocity, u_o, is constant, equal to u in the theory development.

(2) all force and moment coefficients dependent on angle of attack are considered to be linear with angle of attack.

(3) all force and moment coefficients independent of angle of attack are considered to be constant.

(4) a linear relationship exists between x (distance down range) and time for the non-drag case.

(5) roll rate, p , is considered to be constant.

(6) products of force and moment derivatives are negligible, except those involving Z_{δ_ϵ} and M_{δ_ϵ} .

Utilizing these assumptions, and the binomial expansion of $(Z_{\dot{w}}-m)^{-1}$, 2 , 3 , 4 and 5 become:

$$N_1 \approx -\left[\frac{Z_w + ipZ_{pv}}{m}\right] - \left[\frac{M_q + uM_{\dot{w}}}{I_y}\right] - \frac{ipI_x}{I_y} \tag{2a}$$

$$N_2 \approx -u\left[\frac{M_w + ipM_{pv}}{I_y}\right] + \frac{ipI_x}{I_y}\left[\frac{Z_w + ipZ_{pv}}{m}\right] \tag{3a}$$

$$\vec{N}_3 \approx \frac{ipZ_{\delta_\epsilon}\vec{\delta}_\epsilon}{m}\left[1 - \frac{I_x}{I_y}\right] + \frac{uM_{\delta_\epsilon}\vec{\delta}_\epsilon}{I_y} \tag{4a}$$

$$\vec{N}_4 \approx g\left[\frac{pI_x}{I_y}\right] \tag{5a}$$

The solution to Equation 1 is that of tricyclic motion; that is,

$$\vec{w} = \vec{K}_1 e^{\phi_1 t} + \vec{K}_2 e^{\phi_2 t} + \vec{K}_3 e^{ipt} + \vec{K}_4 \tag{6}$$

where the complex coefficients are:

$$\vec{K}_{1,2} = \frac{\dot{\vec{w}}_o - (\phi_{2,1})\,\vec{w}_o + \vec{K}_3\,(\phi_{2,1} - ip)}{\phi_{1,2} - \phi_{2,1}} \tag{7}$$

$$\vec{K}_3 = \frac{\vec{N}_3}{(ip-\phi_1)(ip-\phi_2)} \tag{8}$$

$$\vec{K}_4 = \frac{\vec{N}_4}{N_2} \tag{9}$$

and

$$\phi_{1,2} = -\frac{N_1}{2} \pm \frac{1}{2}\sqrt{N_1^2 - 4N_2} \tag{10}$$

The trajectory equation for free-flight motion:

$$\ddot{\vec{S}} = (\dot{\vec{w}} - iu\vec{q}) \tag{11}$$

An expression for $\vec{q}$ is obtained from the equations of motion

$$\vec{q} = i\dot{\vec{w}}\left[\frac{Z_{\dot{w}} - m}{mu+Z_q}\right] + i\vec{w}\left[\frac{Z_w + ipZp_v}{mu+Z_q}\right] + \left[\frac{iZ_{\delta_\epsilon}\vec{\delta_\epsilon}}{mu+Z_q}\right]e^{ipt} - \left[\frac{mg}{mu+Z_q}\right]$$

$$\vec{q} \approx -i\dot{\vec{w}}\left[1 - \frac{Z_q+Z_{\dot{w}}}{m}\right] + i\vec{w}\left[\frac{Z_w + ipZ_{pv}}{mu}\right] + \left[\frac{iZ_{\delta_\epsilon}\vec{\delta_\epsilon}}{mu}\right]e^{ipt} - \frac{g}{u} \tag{12}$$

yielding a solution of the form:

$$\vec{S} = \vec{k}_1 e^{\phi_1 t} + \vec{k}_2 e^{\phi_2 t} + \vec{k}_3 e^{ipt} + \vec{k}_4 t^2 + \vec{k}_5 t + \vec{k}_6 \tag{13}$$

where the entire expression for the solution is:

$$\vec{S} = \vec{K}_1 e^{\phi_1 t}\left[\frac{1}{\phi_1}\left(\frac{Z_q + uZ_{\dot{w}}}{mu}\right) + \frac{u}{\phi^2}\left(\frac{Z_w + ipZ_{pv}}{mu}\right)\right]$$

$$+ \vec{K}_2 e^{\phi_2 t}\left[\frac{1}{\phi_2}\left(\frac{Z_q + uZ_{\dot{w}}}{mu}\right) + \frac{u}{\phi_2^2}\left(\frac{Z_w + ipZ_{pv}}{mu}\right)\right]$$

$$+ \left[\frac{Z_w + ipZ_{pv}}{m}\vec{K}_3 + \frac{Z_{\delta_\epsilon}\vec{\delta_\epsilon}}{m}\right]\int_0^t\int_0^t e^{ipt}\,dtdt$$

$$+ \left[\frac{Z_q + uZ_{\dot{w}}}{mu}\right]\vec{K}_3\int_0^t e^{ipt} + \left[\frac{\vec{K}_4}{2}\left(\frac{Z_w + ipZ_{pv}}{m}\right) + \frac{ig}{2}\right]t^2$$

$$+ t\left[\dot{\vec{S}}_o + \left(\frac{Z_q + uZ_{\dot{w}}}{mu}\right)(\vec{K}_4 - \vec{w}_o) - \left(\frac{Z_w + ipZ_{pv}}{m}\right)\left(\frac{\vec{K}_1}{\phi_1} + \frac{\vec{K}_2}{\phi_2}\right)\right] \tag{14}$$

$$+ \left[\vec{S}_o - \left(\frac{Z_q + uZ_{\dot{w}}}{mu}\right)\left(\frac{\vec{K}_1}{\phi_1} + \frac{\vec{K}_2}{\phi_2}\right) - \left(\frac{Z_w + ipZ_{pv}}{m}\right)\left(\frac{\vec{K}_1}{\phi_1^2} + \frac{\vec{K}_2}{\phi_2^2}\right)\right]$$

The term $\left(\frac{Z_q + uZ_{\dot{w}}}{mu}\right)$ is of an order of magnitude 10^{-3} and thus is neglected from all further discussion. This reduces 14 to:

$$\vec{S} = \vec{K}_1 e^{\phi_1 t}\left[\frac{u}{\phi_1^2}\left(\frac{Z_w + ipZ_{pv}}{mu}\right)\right] + \vec{K}_2 e^{\phi_2 t}\left[\frac{u}{\phi_2^2}\left(\frac{Z_w + ipZ_{pv}}{mu}\right)\right] \tag{15}$$

$$+ \left[\frac{Z_w + ipZ_{pv}}{m}\vec{K}_3 + \frac{Z_{\delta_\epsilon}\vec{\delta}_\epsilon}{m}\right]\int_0^t\int_0^t e^{ipt}\,dtdt + \left[\frac{\vec{K}_4}{2}\left(\frac{Z_w + ipZ_{pv}}{m}\right) + \frac{ig}{2}\right]t^2$$

$$+ t\left[\dot{\vec{S}}_o - \left(\frac{Z_w + ipZ_{pv}}{m}\right)\left(\frac{\vec{K}_1}{\phi_1} + \frac{\vec{K}_2}{\phi_2}\right)\right] + \left[\vec{S}_o - \left(\frac{Z_w + ipZ_{pv}}{m}\right)\left(\frac{\vec{K}_1}{\phi_1^2} + \frac{\vec{K}_2}{\phi_1^2}\right)\right].$$

By further inspection, terms with ϕ_1^2 and ϕ_2^2 will be negligible since they contain products of force and moment derivatives. Equation 15 becomes:

$$\vec{S} = \left[\frac{Z_w + ipZ_{pv}}{m}\vec{K}_3 + \frac{Z_{\delta_\epsilon}\vec{\delta}_\epsilon}{m}\right]\int_0^t\int_0^t e^{ipt}\,dtdt + \left[\frac{\vec{K}_4}{2}\left[\frac{Z_w + ipZ_{pv}}{m}\right] + \frac{ig}{2}\right]t^2$$

$$+ t\left[\dot{\vec{S}}_o - \left(\frac{Z_w + ipZ_{pv}}{m}\right)\left(\frac{\vec{K}_1}{\phi_1} + \frac{\vec{K}_2}{\phi_2}\right)\right] + \vec{S}_o \tag{16}$$

Equation 16 contains only the significant terms in dispersion theory. This equation is valid for all values of roll rate.

High Roll Rate Theory

For roll rates greater than 100 rad/sec, Equation 16 reduces to an approximate solution. Integration of the double integral gives:

$$\int_o^t\int_o^t e^{ipt}\,dtdt = \frac{e^{ipt}}{(ip)^2} - \frac{t}{ip} - \frac{1}{(ip)^2} \tag{17}$$

For high roll rates, the first and third terms go to zero, leaving only the second term to affect dispersion. Applying this approximation to Equation 16 :

$$\vec{S} = \left[\frac{\vec{K}_4}{2}\left(\frac{Z_w + ipZ_{pv}}{m}\right) + \frac{ig}{2}\right]t^2 + \left[\dot{\vec{S}}_o - \left(\frac{Z_w + ipZ_{pv}}{m}\right)\left(\frac{\vec{K}_1}{\phi_1} + \frac{\vec{K}_2}{\phi_2} + \frac{\vec{K}_3}{ip}\right) + \frac{iZ_{\delta_\epsilon}\vec{\delta}_\epsilon}{mp}\right]t + \vec{S}_o \tag{18}$$

where, by applying previous aerodynamic relationships:

$$\left(\frac{\vec{K}_1}{\phi_1} + \frac{\vec{K}_2}{\phi_2} + \frac{\vec{K}_3}{ip}\right) = \left[\frac{\dot{\vec{w}}_o - \vec{w}_o(\phi_1 + \phi_2)}{-\phi_1\phi_2}\right] + \left[\frac{\frac{uM_{\delta_\epsilon}\vec{\delta}_\epsilon}{I_y} + i\,\frac{pZ_{\delta_\epsilon}\vec{\delta}_\epsilon}{m}\left(1 - \frac{I_x}{I_y}\right)}{(ip)\;\phi_1\phi_2}\right] \tag{19}$$

$$\phi_1 + \phi_2 = -N_1$$

$$\phi_1\phi_2 = N_2$$

$$\vec{K}_4 = -gpI_x\left[\frac{1}{\left(M_\alpha + \frac{p^2I_x}{mu}Z_{p\beta}\right) + i\left(pM_{p\beta} - \frac{pI_x}{mu}Z_\alpha\right)}\right] \tag{20}$$

Substituting 19 and 20 into 18 and expanding the various terms:

$$\vec{S} = \frac{igt^2}{2}\left[1 + \frac{ipI_x}{mud}\left[\frac{C_{z_\alpha} + i\left(\frac{pd}{2u}\right) C_{z_{p\beta}}}{\left(C_{M_\alpha} + \frac{pI_x}{mud}\frac{pd}{2u} C_{z_{p\beta}}\right) + i\left(C_{M_{p\beta}}\frac{pd}{2u} - \frac{pI_x}{mud} C_{z_\alpha}\right)}\right]\right]$$

$$+ ut\left[\frac{\dot{\vec{S}}_o}{u} + - \frac{I_y}{mud}\left[\frac{C_{z_\alpha} + i\frac{pd}{2u} C_{z_{p\beta}}}{\left(C_{M_\alpha} + \frac{pI_x}{mud}\frac{pd}{2u} C_{z_{p\beta}}\right) + i\left(C_{M_{p\beta}}\frac{pd}{2u} - \frac{pI_x}{mud} C_{z_\alpha}\right)}\right]\right.$$

$$+ i\, C_{z_{\delta_\epsilon}} \vec{\delta_\epsilon}\left[\frac{\rho u \pi d^2}{8mp}\right] \tag{21}$$

$$\left.\left[\dot{\vec{\alpha}}_o - \alpha_o\left(\frac{ipI_x}{I_y}\right) - C_{M_{\delta_\epsilon}}\vec{\delta_\epsilon}\left(\frac{\rho u^2 \pi d^3}{8pI_y}\right) - C_{z_{\delta_\epsilon}}\vec{\delta_\epsilon}\left(1 - \frac{I_x}{I_y}\right)\frac{\rho u \pi d^2}{8m}\right]\right] + \vec{S}_o$$

Employing assumption 6 ,

$$\vec{S} = \frac{ig}{2}\left(\frac{x}{u}\right)^2\left[1 + \frac{ipI_x}{mud} A\right] + (x)\left[\frac{\dot{\vec{S}}_o}{u} + iC_{z_{\delta_\epsilon}}\vec{\delta_\epsilon}\left(\frac{\rho u \pi d^2}{8mp}\right)\right. \tag{22}$$

$$- \frac{I_y}{mud} A\left[\dot{\vec{\alpha}}_o - \vec{\alpha}_o\left(\frac{ipI_x}{I_y}\right) - C_{M_{\delta_\epsilon}}\vec{\delta_\epsilon}\left(\frac{\rho u^2 \pi d^3}{8pI_y}\right)\right.$$

$$\left.\left. - C_{z_{\delta_\epsilon}}\vec{\delta_\epsilon}\left(1 - \frac{I_x}{I_y}\right)\frac{\rho u \pi d^2}{8m}\right]\right] + \vec{S}_o$$

where

$$A = \frac{C_{z_\alpha} + i\left(\frac{pd}{2u}\right) C_{z_{p\beta}}}{\left(C_{M_\alpha} + \frac{pI_x}{mud}\frac{pd}{2u} C_{z_{p\beta}}\right) + i\left(C_{M_{p\beta}}\frac{pd}{2u} - \frac{pI_x}{mud} C_{z_\alpha}\right)}$$

The mil-relation offers a method to define the Jump Angle from Equation 22.

$$\text{Jump Angle} = \frac{\vec{S}}{x}(10^3) \tag{23}$$

$$\overrightarrow{J.A.} = \frac{ig}{2}\left(\frac{x}{u^2}\right)(10^3)\left[1+\frac{ipI_x}{mud}A\right] + (10^3)\left[\frac{\dot{\vec{S}}_o}{u} + iC_{Z_{\delta_\epsilon}}\vec{\delta}_\epsilon\left(\frac{\rho u\pi d^2}{8mp}\right)\right.$$
$$- \frac{I_y}{mud}A\left[\dot{\vec{\alpha}}_o - \vec{\alpha}_o\left(\frac{ipI_x}{I_y}\right) - C_{M_{\delta_\epsilon}}\vec{\delta}_\epsilon\left(\frac{\rho u^2\pi d^3}{8pI_y}\right)\right. \tag{24}$$
$$\left.\left. - C_{Z_{\delta_\epsilon}}\vec{\delta}_\epsilon\left(1-\frac{I_x}{I_y}\right)\frac{\rho u\pi d^2}{8m}\right]\right] + \frac{1000}{x}\vec{S}_o$$

Equation 24 gives an approximation for the Jump Angle for high roll rate cases with gravity, at any position x down range.

Low Roll Rate Theory

For roll rates less than 100 rad/sec but having a parameter, pt, greater than 1, Equation 16 can be reduced to another approximation. As before, integration of the double integral yields Equation 17

$$\int_0^t\int_0^t e^{ipt} = \frac{e^{ipt}}{(ip)^2} - \frac{t}{ip} - \frac{1}{(ip)^2}$$

For low roll rates all three terms are significant to dispersion. Equation 16 now becomes:

$$\vec{S} = \left(\frac{Z_w + ipZ_{p\beta}}{m}\vec{K}_3 + \frac{Z_{\delta_\epsilon}\vec{\delta}_\epsilon}{m}\right)\left(1-e^{ipt}\right)\frac{1}{p^2} + \left[\frac{\vec{K}_4}{2}\left(\frac{Z_w+ipZ_{p\beta}}{m}\right) + \frac{ig}{2}\right]t^2$$
$$+\left[\dot{\vec{S}}_o - \left(\frac{Z_w+ipZ_{p\beta}}{m}\right)\left(\frac{\vec{K}_1}{\phi_1} + \frac{\vec{K}_2}{\phi_2}\right) + \frac{\vec{K}_3}{ip} + \frac{iZ_{\delta_\epsilon}\vec{\delta}_\epsilon}{mp}\right]t + \vec{S}_o \tag{25}$$

The $\vec{K}_3$ arm, or rolling trim vector must be separately examined. From Equation 8,

$$\vec{K}_3 = \frac{\vec{N}_3}{(ip-\phi_1)(ip-\phi_2)}$$

or

$$\vec{K}_3 = \frac{\vec{N}_3}{(ip)^2 - ip(\phi_1+\phi_2)+\phi_1\phi_2}$$

Numerical inspection of the three denominator terms indicates that the first two terms can be neglected. Each term is not only less than 1% of the third term but also they're subtracted from one another to make their contribution even more minimal. Thus K_3 is approximated by,

$$\vec{K}_3 = -\frac{I_y}{md}\left[\frac{ipC_{Z_{\delta_\epsilon}}\vec{\delta}_\epsilon\left(1-\frac{I_x}{I_y}\right) + i\frac{mud}{I_y}\,C_{M_{\delta\epsilon}}\vec{\delta}_\epsilon}{\left[C_{M_\alpha} + \frac{pI_x}{mud}\left(\frac{pd}{2u}\right)C_{Z_{p\beta}}\right] + i\left[C_{M_{p\beta}}\left(\frac{pd}{2u}\right) - \left(\frac{pI_x}{mud}\right)C_{Z_\alpha}\right]}\right]$$

for low roll rates, the second term in the numerator and the first term in the denominator dominate all other terms and become the only significant terms. Thus,

$$\vec{K}_3 = -\frac{uiC_{M_{\delta\epsilon}}\vec{\delta}_\epsilon}{C_{M_\alpha}} \tag{26}$$

The same approximation holds true for applicable terms in Equation 25 , thus reducing the jump angle equation to:

$$\begin{aligned}\vec{J.A.} = \Bigg\{ & \frac{ig}{2}\left(\frac{x}{u^2}\right) + \frac{\rho u^2\pi d^2}{8\,mp^2}\left[C_{Z_{\delta_\epsilon}}\vec{\delta}_\epsilon - i\left(\frac{C_{Z_\alpha}}{C_{M_\alpha}}\right)C_{M_{\delta_\epsilon}}\vec{\delta}_\epsilon\right](1-e^{ipt}) \\ & + \Bigg[\frac{\vec{\dot{S}}_o}{u} + iC_{Z_{\delta_\epsilon}}\vec{\delta}_\epsilon\left(\frac{\rho u\pi d^2}{8\,mp}\right) - \frac{I_y}{mud}A\Bigg[\vec{\dot{\alpha}}_o - C_{M_{\delta_\epsilon}}\vec{\delta}_\epsilon\left(\frac{\rho u^2\pi d^3}{8\,pI_y}\right) \\ & - C_{Z_{\delta_\epsilon}}\vec{\delta}_\epsilon\left(1-\frac{I_x}{I_y}\right)\frac{\rho u\pi d^2}{8m}\Bigg]\Bigg] + \frac{\vec{S}_o}{x}\Bigg\}(10^3)\end{aligned}$$

Combining terms and dropping the negligible second last term,

$$\overrightarrow{J.A.} = \left[\frac{ig}{2}\left(\frac{x}{u^2}\right) + \frac{\rho u^2 \pi d^2}{8m}\left[C_{Z_{\delta_\epsilon}}\vec{\delta}_\epsilon - i\left(\frac{C_{Z_\alpha}}{C_{m_\alpha}}\right) C_{M_{\delta_\epsilon}}\vec{\delta}_\epsilon\right]\left[\frac{1}{p^2 x} + \frac{i}{pu} - \frac{e^{ipt}}{p^2 x}\right]\right.$$
$$\left. + \left[\frac{\vec{\dot{S}}_o}{u} - \frac{I_y}{mud}\left(\frac{C_{Z_\alpha}}{C_{M_\alpha}}\right)\vec{\dot{\alpha}}_o\right] + \frac{\vec{S}_o}{x}\right](10^3) \tag{27}$$

Expanding e^{ipt} to $\cos p\left(\frac{x}{u}\right) + i \sin p\left(\frac{x}{u}\right)$,

$$\overrightarrow{J.A.} = \left\{\frac{ig}{2}\left(\frac{x}{u^2}\right) + \frac{\rho u^2 \pi d^2}{8mx}\left[C_{Z_{\delta_\epsilon}}\vec{\delta}_\epsilon - i\left(\frac{C_{Z_\alpha}}{C_{M_\alpha}}\right) C_{M_{\delta_\epsilon}}\vec{\delta}_\epsilon\right]\left[\frac{1}{p^2}\left(1 - \cos p\frac{x}{u}\right)\right.\right.$$
$$\left.\left. + \frac{i}{p}\left(\frac{x}{u} - \frac{\sin p\frac{x}{u}}{p}\right)\right] + \left[\frac{\vec{\dot{S}}_o}{u} - \frac{I_y}{mud}\left(\frac{C_{Z_\alpha}}{C_{M_\alpha}}\right)\vec{\dot{\alpha}}_o\right] + \frac{\vec{S}_o}{x}\right\}(10^3) \tag{28}$$

Equation 28 accurately approximates the jump angle for roll rates:

$p > 100$ rad/sec

$pt \geq 1.0$

Very Slow Roll Rate Theory

For very low roll rates; that is, $p \geq 0$ and $pt \leq 1$, Equation 28 is again applicable.

One approximation is used, however, and that is that $\cos\left(\frac{px}{u}\right)$ and $\sin\left(\frac{px}{u}\right)$ are approximated by power series.

$$\cos\left(\frac{px}{u}\right) = 1 - \frac{(px)^2}{2u^2} + \frac{(px)^4}{24u^4} - \frac{(px)^6}{720u^6} + \dots$$
$$\sin\left(\frac{px}{u}\right) = \frac{px}{u} - \frac{(px)^3}{6u^3} + \frac{(px)^5}{120u^5} - \frac{(px)^7}{5040u^7} + \dots \tag{29}$$

Substituting and simplifying,

$$\overrightarrow{J.A.} = \left\{\frac{ig}{2}\left(\frac{x}{u^2}\right) + \frac{\rho\pi d^2 x}{16m}\left[C_{Z_{\delta_\epsilon}}\overrightarrow{\delta_\epsilon} - i\left(\frac{C_{Z_\alpha}}{C_{M_\alpha}}\right)C_{M_{\delta_\epsilon}}\overrightarrow{\delta_\epsilon}\right]\left[\left(1 - \frac{1}{12}\left(\frac{px}{u}\right)^2 + \frac{1}{360}\left(\frac{px}{u}\right)^4\right) + i\left(\frac{px}{3u} - \frac{1}{60}\left(\frac{px}{u}\right)^3 + \frac{1}{2520}\left(\frac{px}{u}\right)^5\right)\right] + \left[\frac{\dot{\overrightarrow{S_o}}}{u} - \frac{I_y}{mud}\left(\frac{C_{Z_\alpha}}{C_{M_\alpha}}\right)\overrightarrow{\alpha_o}\right] + \frac{\overrightarrow{S_o}}{x}\right\}(10^3) \tag{30}$$

VALIDATION OF THEORY

The theoretical expressions for Jump Angle; Equations 24, 28 and 30; show that the dispersion depends on the initial conditions, aerodynamic coefficients, distance downrange , and mass parameters. Dispersion for this theoretical analysis is defined to be the deviation from the line of fire. By analyzing only one Flechette configuration to validate the theory, the producibility Ground Point, and taking all cases to be evaluated at 1000 feet downrange , then the expression for the Jump Angle can only be affected by the initial conditions and aerodynamic coefficients.

To assure that the three equations for Jump Angle are valid and to show the effects for various initial conditions and aerodynamic coefficients, the expressions for the Jump Angle were evaluated for a series of cases and compared to numerical integration of the six-degree-of-freedom equations of motion, (6-D). A sample case run can be found in Appendix A-2. The series of cases is broken down into various phases of development. Phase I considers various initial conditions but with only the restoring and damping aerodynamic coefficients. This phase validates the use of initial conditions alone. Phase II utilizes a set of constant initial conditions, except for roll rate, and constant restoring and damping coefficients, while varying Magnus coefficients to determine their influence. Phase III brings into consideration all the aerodynamic coefficients to include the configurational asymmetry coefficients. Different coefficients are used by varying the initial velocity and roll rates are varied to evaluate high, low, and very low roll theories. Phase IV considers the effects of gravity for various initial velocities and roll rates. No configurational asymmetries are used in order to isolate the gravitational influence. Values for all coefficients are found in Appendix A1, as well as other data including mass parameters. Since computations were done at 1000 ft downrange, the Jump Angle in mils is equivalent to the deviation from the line of fire in feet for all presented cases. The axis system used throughout this analysis is illustrated in the list of symbols.

Phase I

To validate the effects of initial conditions with restoring and damping coefficients only, 36 cases were evaluated using the high roll rate theory, Equation 24. The cases are divided into 4 sections isolating different initial conditions and their effects.

Cases 1-9

The first section shows the effects of roll rate and velocity with zero $\dot{\vec{S}}_o$, $\vec{\alpha}_o$ and $\dot{\vec{\alpha}}_o$

TABLE I

THEORY VALIDATION, RESTORING AND DAMPING MOMENTS, CASES 1-9

CASE	Initial Conditions					Coefficients			$\overrightarrow{J.A}$ (mils)	
	$\vec{\dot{S}}_o$	$\vec{\alpha}_o$	$\vec{\dot{\alpha}}_o$	p_o	u_o	C_{Z_α}, C_{M_α}, $C_{M_q} + C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$, $C_{M_{p\beta}}$	C_{YE}, C_{ZE}, C_{ME}, C_{NE}	6-D	Theory
1	0	0	0	31416	5000	A1	0	0	0 + 0i	0 + 0i
2	0	0	0	18850					0 + 0i	0 + 0i
3	0	0	0	6283					0 + 0i	0 + 0i
4	0	0	0	31416	3000				0 + 0i	0 + 0i
5	0	0	0	18850					0 + 0i	0 + 0i
6	0	0	0	6283					0 + 0i	0 + 0i
7	0	0	0	31416	1000				0 + 0i	0 + 0i
8	0	0	0	18850					0 + 0i	0 + 0i
9	0	0	0	6283					0 + 0i	0 + 0i

Table I clearly indicates that no deviation from the line of fire occurs if $\vec{\dot{S}}_C$, $\vec{\alpha}_o$, and $\vec{\dot{\alpha}}_o$ are set to zero. Roll rate and velocity changes have no effect on the Jump Angle for this particular situation. This is a trivial solution, it being obvious from inspection of Equation 24.

Cases 10-18

The second section gives the effects of initial translational velocity, $\vec{\dot{S}}_o = \vec{\dot{y}} + i\vec{\dot{z}}$, with various roll rates and velocities. To assure the solution is correct in three dimensional space, the initial translation velocity is given in both y and iz directions. Equation 24 reduces to:

$$\overrightarrow{J.A.} = \frac{1000}{u} \vec{\dot{S}}_o$$

TABLE II

THEORY VALIDATION, RESTORING AND DAMPING MOMENTS, CASES 10-18

CASE	Initial Conditions					Coefficients			$\vec{J.A.}$ (mils)	
	$\vec{S}_o$	$\vec{\alpha}_o$	$\vec{\dot{\alpha}}_o$	p_o	u_o	C_{Z_α} C_{M_α} $C_{M_q}+C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$ $C_{M_{p\beta}}$	C_{YE} C_{ZE} C_{ME} C_{NE}	6-D	Theory
10	100+ 100i	0	0	31416					20.002 + 20.006 i	20.000 + 20.000 i
11	100 + 100 i	0	0	18850	5000				20.002 + 20.006 i	20.000 + 20.000 i
12	100 + 100 i	0	0	6283					20.002 + 20.006 i	20.000 + 20.000 i
13	100 + 100 i	0	0	31416					33.346 + 33.368 i	33.333 + 33.333 i
14	100 + 100 i	0	0	18850	3000	A1	0	0	33.346 + 33.368 i	33.333 + 33.333 i
15	100 + 100 i	0	0	6283					33.346 + 33.368 i	33.333 + 33.333 i
16	100 + 100 i	0	0	31416					100.254 + 100.765 i	100.000 + 100.000 i
17	100 + 100 i	0	0	18850	1000				100.254+ 100.764 i	100.000 + 100.000 i
18	100 + 100 i	0	0	6283					100.257 + 100.765 i	100.000+ 100.000 i

The correlation between the theory and the 6-D integration for Cases 10-18 is excellent as shown in Table II. The Jump Angle is seen to be affected by velocity but not roll rate, as would be expected from the reduced Jump Angle equation. Figure I illustrates the deviation from the line of fire for initial velocities of 5000 ft/sec (Cases 10-12), 3000 ft/sec (Cases 13-15) and 1000 ft/sec (Cases 16-18). Since the theory and 6-D

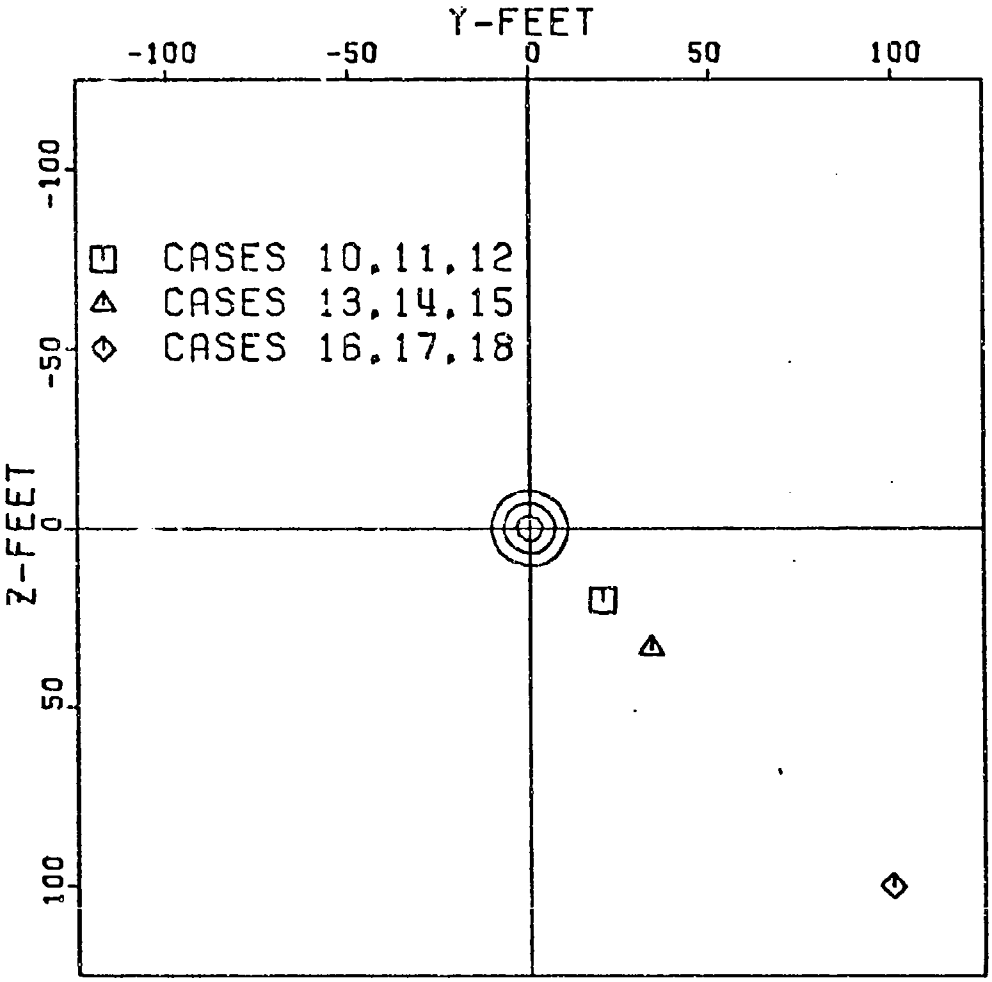


Figure 1. Dispersion: Phase I Cases 10-18

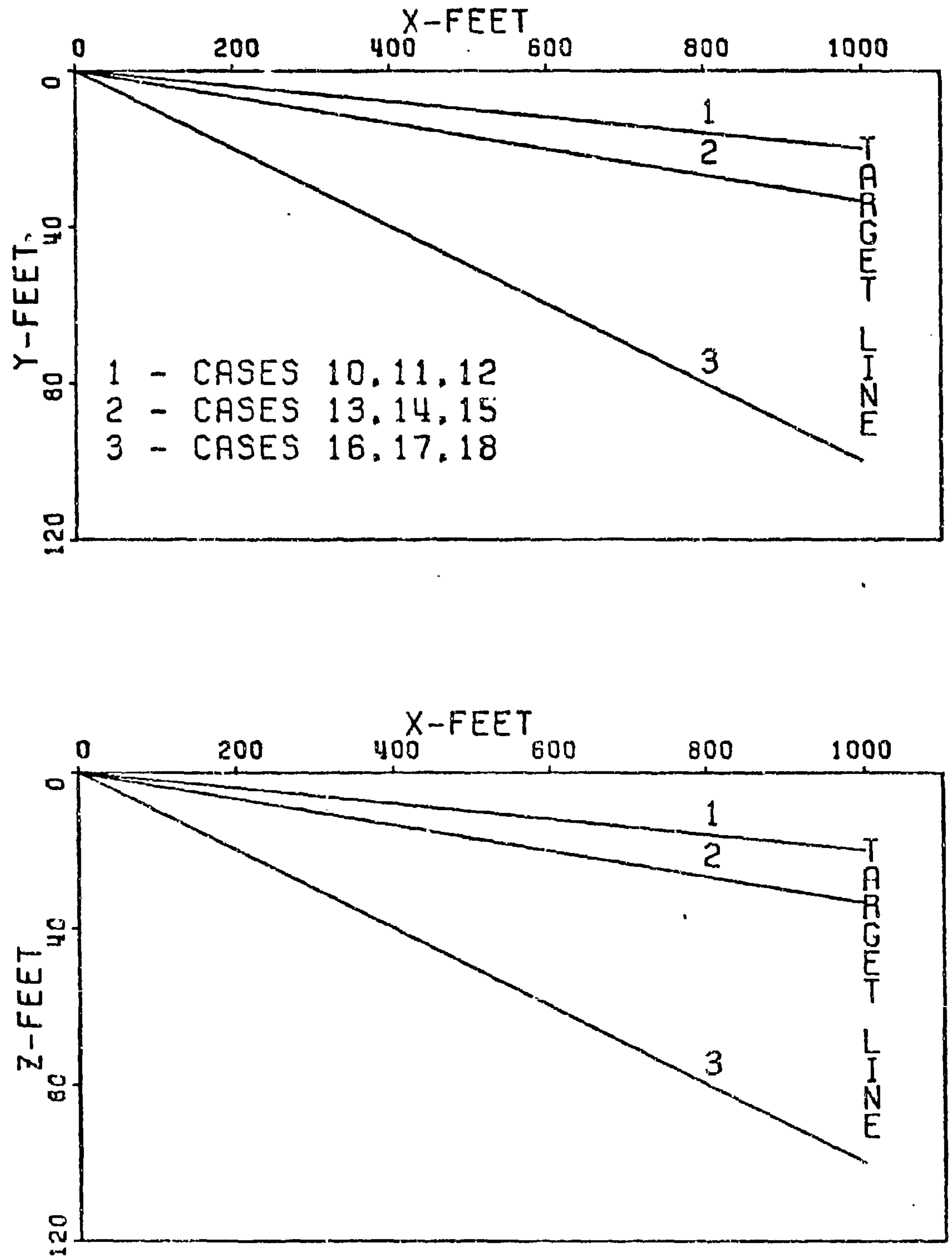


Figure 2. Trajectories, Cases 10-18

are so close, they are plotted as one point. Figure 2 illustrates the trajectory in both the x-y and x-z planes. The deviation from the line of fire is linear with distance downrange in both planes. This would be expected with no gravitational force acting.

Cases 19-27

The third section gives the effects of initial angle of attack, $\vec{\alpha_0}$, with various roll rates and velocities. Again a complex initial condition is used to validate the theory in three dimensional space. Equation 24 reduces to:

$$\overrightarrow{J.A.} = i\vec{\alpha_0}\left(\frac{pI_x}{mud}\right)\left[\frac{C_{Z_\alpha}}{C_{M_\alpha} - i\left(\frac{pI_x}{mud}\right)C_{Z_\alpha}}\right]1000$$

Table III shows the range of error between the 6-D computation and the theory to be 0.036 to 0.040 mils in the y-direction and 0.038 to 0.041 mils in the z-direction. Although the y-direction deviations differ in sign, the error between them is approximately 0.00225 degrees, an extremely small angle. This angle will give an approximate deviation of 0.04 feet from the line of fire at 1000 feet downrange. With the $\overrightarrow{J.A.}$ being so close to zero it can be expected that the signs may differ due to computational errors. The results do show Jump Angle variance with both roll rate and velocity. The largest changes occur as velocity goes to 1000 ft/sec.

TABLE III

THEORY VALIDATION, RESTORING AND DAMPING MOMENTS, CASES 19-27

CASE	Initial Conditions					Coefficients			$\overrightarrow{J.A.}$ (mils)	
	$\vec{\delta}_o$	$\vec{\alpha}_o$	$\dot{\vec{\alpha}}_o$	p_o	u_o	C_{Z_α} C_{M_α} $C_{M_q}+C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$ $C_{M_{p\beta}}$	C_{YE} C_{ZE} C_{ME} C_{NE}	6-D	Theory
19	0	1+i	0	31416					0.012+ 0.068i	-0.027 +0.027i
20	0	1+i	0	18850	5000				0.023+ 0.058i	-0.017 +0.017i
21	0	1+i	0	6283					0.034+ 0.047i	-0.006 +0.006i
22	0	1+i	0	31416					0.012+ 0.067+	-0.026 +0.026i
23	0	1+i	0	18850	3000	A1	0	0	0.022+ 0.056i	-0.016 +0.016i
24	0	1+i	0	6283					0.033+ 0.046i	-0.005 +0.005i
25	0	1+i	0	31416					-0.037+ 0.111i	-0.073 +0.073i
26	0	1+i	0	18850	1000				-0.008+ 0.082i	-0.044 +0.044i
27	0	1+i	0	6283					0.021+ 0.053i	-0.015 +0.015i

Cases 28-36

The fourth section gives the effects of initial angular rate $\dot{\vec{\alpha}}_o$, with varying roll rate and velocity. An angular rate of 250 rad/sec is used in both directions of the complex plane to test validity in three dimensional space. Equation 24 reduces to:

$$\overrightarrow{J.A.} = -\vec{\dot{\alpha}}_o \left(\frac{I_y}{mud}\right) \left[\frac{C_{Z_\alpha}}{C_{M_\alpha} - i\left(\frac{pI_x}{mud}\right) C_{Z_\alpha}}\right] 1000$$

TABLE IV

THEORY VALIDATION, RESTORING AND DAMPING MOMENTS, CASES 28-36

CASE	Initial Conditions					Coefficients			$\overrightarrow{J.A.}$ (mils)	
	$\vec{\dot{S}}_o$	$\vec{\alpha}_o$	$\vec{\dot{\alpha}}_o$	p_o	u_o	C_{Z_α} C_{M_α} $C_{M_q}+C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$ $C_{M_{p\beta}}$	C_{YE} C_{ZE} C_{ME} C_{NE}	6-D	Theory
28	0	0	250+ 250i	31416					-2.027 -2.034i	-2.073 -2.073i
29	0	0	250+ 250i	18850	5000				-2.025 -2.030i	-2 073 -2.073i
30	0	0	250+ 250i	6283					-2.027 -2.029i	-2.073 -2.073i
31	0	0	250+ 250i	31416					-1.961 -1 967i	-1.970 -1.970i
32	0	0	250+ 250i	18850	3000	A1	0	0	-1.962 -1.966i	-1.970 -1.970i
33	0	0	250+ 250i	6283					-1.964 -1.964i	-1.970 -1.970i
34	0	0	250+ 250i	31416					-5.238 -5.274i	-5.540 -5.540i
35	0	0	250+ 250i	18850	1000				-5.243 -5.264i	-5.540 -5.540i
36	0	0	250+ 250i	6283					-5.254 -5.260i	-5.540 -5.540i

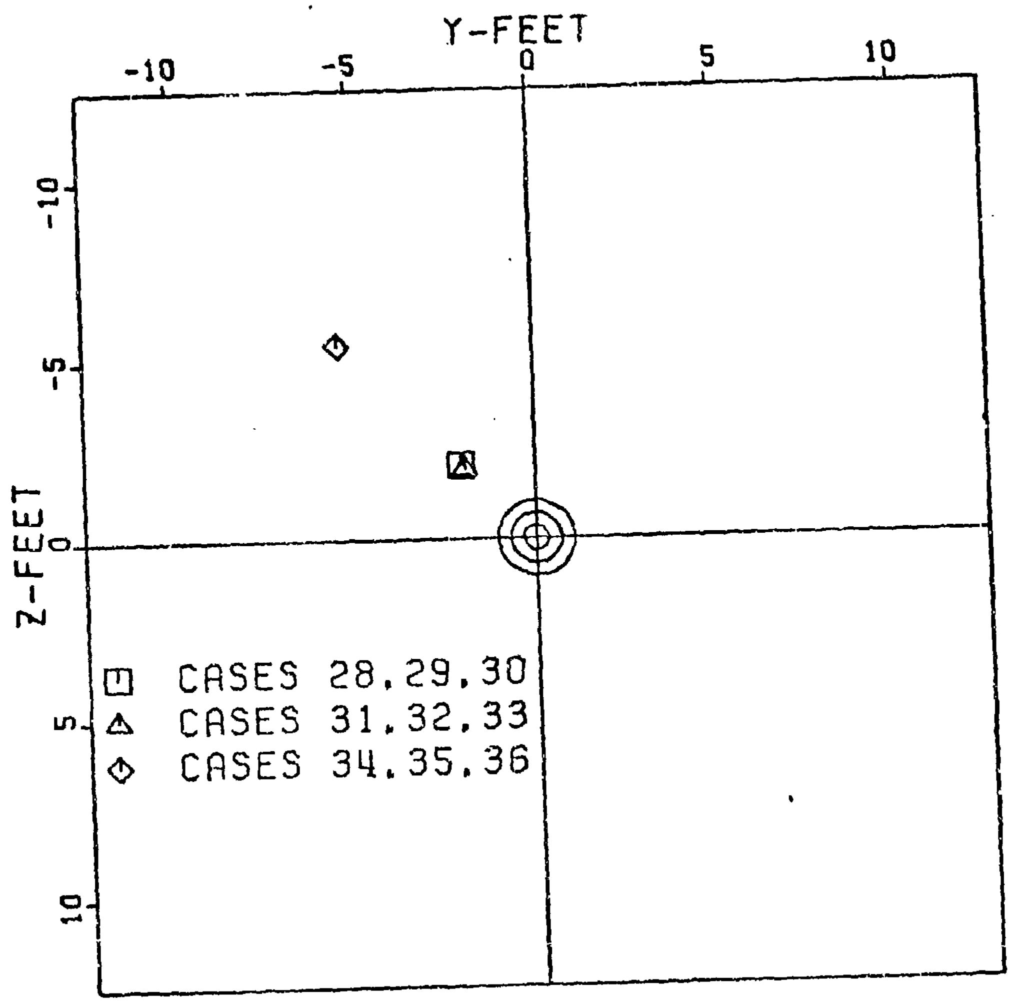
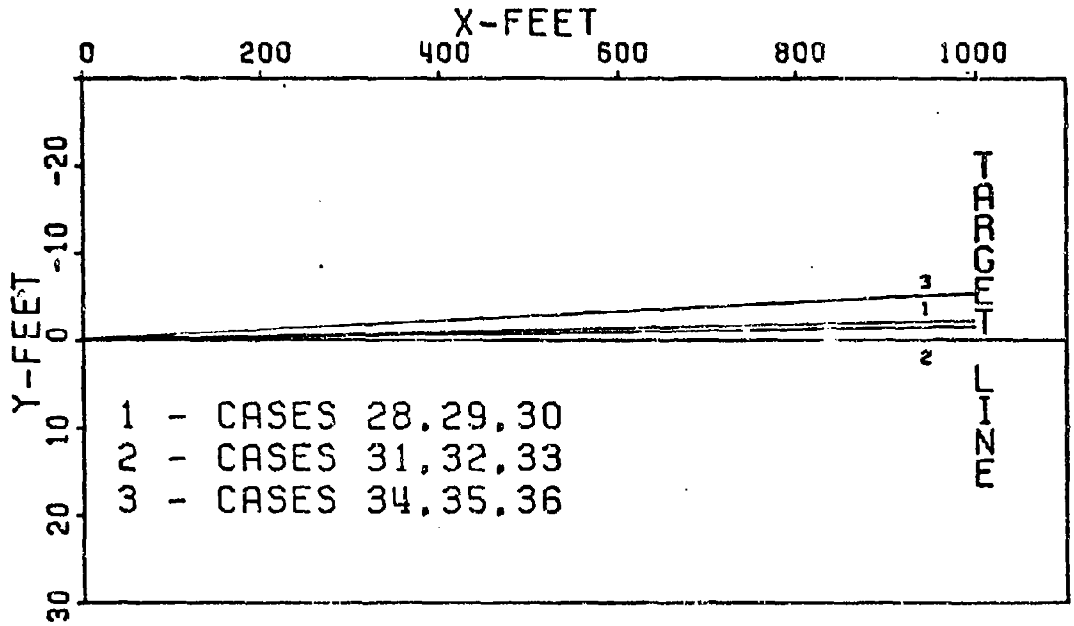


Figure 3. Dispersion: Phase I Cases 28-36



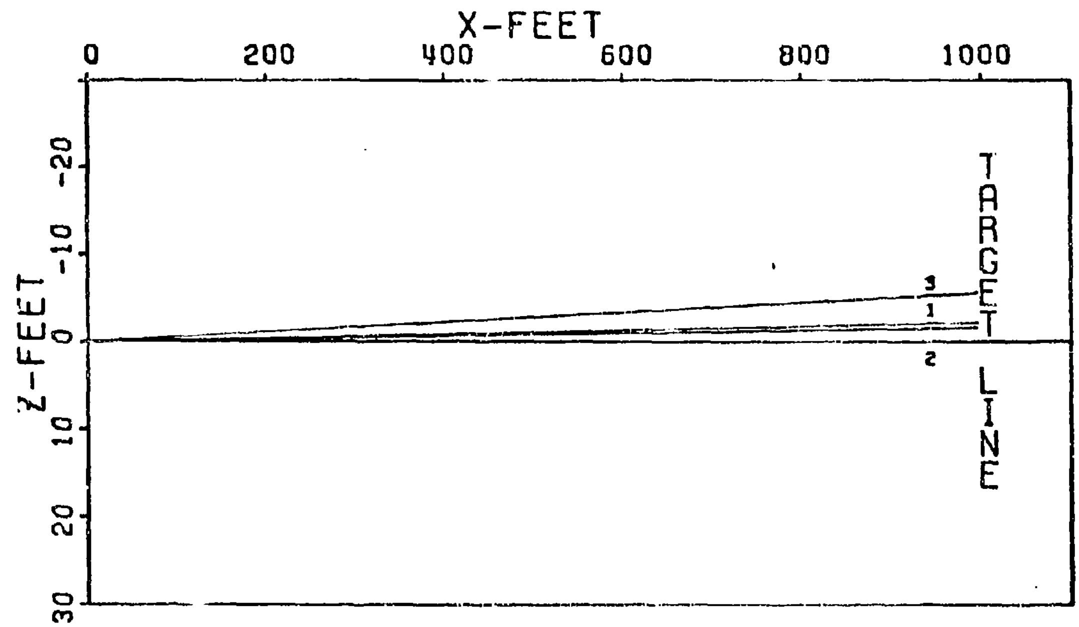


Figure 4. Trajectories, Cases 28-36

Table IV indicates excellent agreement between the theory and 6-D computations. Roll rate is found not to affect the Jump Angle appreciably but velocity does, as would be expected from the reduced Jump Angle equation. Figure 3 shows the dispersion pattern while Figure 4 illustrates the trajectories. Cases 28,29, and 30 are plotted as one point due to the small difference between them. Cases 31, 32, 33 and 34, 35, and 36 are plotted similarly.

Phase II

To validate the effect of Magnus Forces and Moments on the dispersion of flechettes, 21 Cases were run varying the initial roll rate and Magnus Coefficients. All other conditions were held constant. The variance of Magnus coefficients with Mach number had to be chosen since no data was available. Arbitrarily, the ratio of $C_{z_{p\beta}}/C_{M_{p\beta}}$ was chosen to be the same as that of $C_{z_\alpha}/C_{M_\alpha}$. The Magnus Coefficients used are presented as functions of Mach Number in Appendix A1 with only the values at Mach 4.5 tabulated here for identification sake:

TABLE V

MAGNUS COEFFICIENTS
AT MACH 4.5

$C_{z_{p\beta}}$	$C_{M_{p\beta}}$
$\pm$ 34.8	$\pm$ 110.0
$\pm$ 31.6	$\pm$ 100.0
$\pm$ 28.4	$\pm$ 90.0

Equation 24 now becomes:

$$\overrightarrow{J.A.} = \left[\frac{\dot{\vec{S}}_o}{u} - \frac{I_y}{mud}\left[\dot{\vec{\alpha}}_o - i\vec{\alpha}_o\left(\frac{pI_x}{I_y}\right)\right]\right.$$

$$\left.\left[\frac{C_{Z_\alpha} + i\left(\frac{pd}{2u}\right)C_{Z_{p\beta}}}{\left(C_{M_\alpha} + \frac{pI_x}{mud}\ \frac{pd}{2u}\ C_{Z_{p\beta}}\right) + i\left(C_{M_{p\beta}}\frac{pd}{2u} - \frac{pI_x}{mud}\ C_{Z_\alpha}\right)}\right]\right] 1000$$

Initial conditions used in this section are consistent with those of other sections to provide a basis for comparison. Three cases of zero Magnus were run, one at each roll rate to provide a standard to judge the influence of Magnus.

The effects of Magnus coefficients on dispersion are minimal as seen in Table VI. The variance between the zero Magnus cases and any other case is found not to be greater then 0.209 mils (or feet at 1000 feet of range). In order to obtain the maximum Magnus effects, the largest possible Magnus coefficients were used. Hence, $C_{Z_{p\beta}} = 34.8$ and $C_{M_{p\beta}} = 110.0$ are the largest possible coefficients since cases 40 and 49 become unstable. Table VI indicates the effects (for positive Magnus coefficients)

(1) increasing horizontal dispersion with increasing p

(2) decreasing vertical dispersion with increasing p

(3) increasing horizontal dispersion with increasing Magnus

(4) decreasing vertical dispersion with increasing Magnus

TABLE VI

THEORY VALIDATION, MAGNUS, CASES 37-57

CASE	Magnus Forces & Moments \ Roll Rate	p_o 31416 rad/sec	p_o 18850 rad/sec	p_o 6283 rad/sec
37 38 39	$C_{Z_{p\beta}} = 0.0$ $C_{M_{p\beta}} = 0.0$	(6-D) 17.994+ 18.042i Theory 17.900+ 17.954i	(6-D) 18.003+ 18.032i Theory 17.910+ 17.944i	(6-D) 18.013+ 18.022i Theory 17.921+ 17.933i
40 41 42	$C_{Z_{p\beta}} = 34.8$ $C_{M_{p\beta}} = 110.0$	Unstable	18.141+ 17.903i 17.909+ 17.942i	18.057+ 17.979i 17.920+ 17.931i
43 44 45	$C_{Z_{p\beta}} = 31.6$ $C_{M_{p\beta}} = 100.0$	18.203+ 17.849i 17.899 17.954i	18.123+ 17.915i 17.909 17.942i	18.053+ 17.982i 17.920+ 17.931i
46 47 48	$C_{Z_{p\beta}} = 28.4$ $C_{M_{p\beta}} = 90.0$	18.183+ 17.869i 17.899 17.954i	18.114+ 17.925i 17.909 17.942i	18.050+ 17.987i 17.920+ 17.931i
49 50 51	$C_{Z_{p\beta}} = -34.8$ $C_{M_{p\beta}} = -110.0$	Unstable	17.877+ 18.170i 17.090+ 17.942i	17.969+ 18.067i 17.920+ 17.931i
52 53 54	$C_{Z_{p\beta}} = -31.6$ $C_{M_{p\beta}} = -100.0$	17.807+ 18.258i 17.899+ 17.954i	17.888+ 18.158i 17.909+ 17.942i	17.973+ 18.063i 17.920+ 17.931i
55 56 57	$C_{Z_{p\beta}} = -28.4$ $C_{M_{p\beta}} = -90.0$	17.826+ 18.233i 17.899+ 17.954i	17.900+ 18.144i 17.909+ 17.942i	17.977+ 18.059i 17.820+ 17.931i

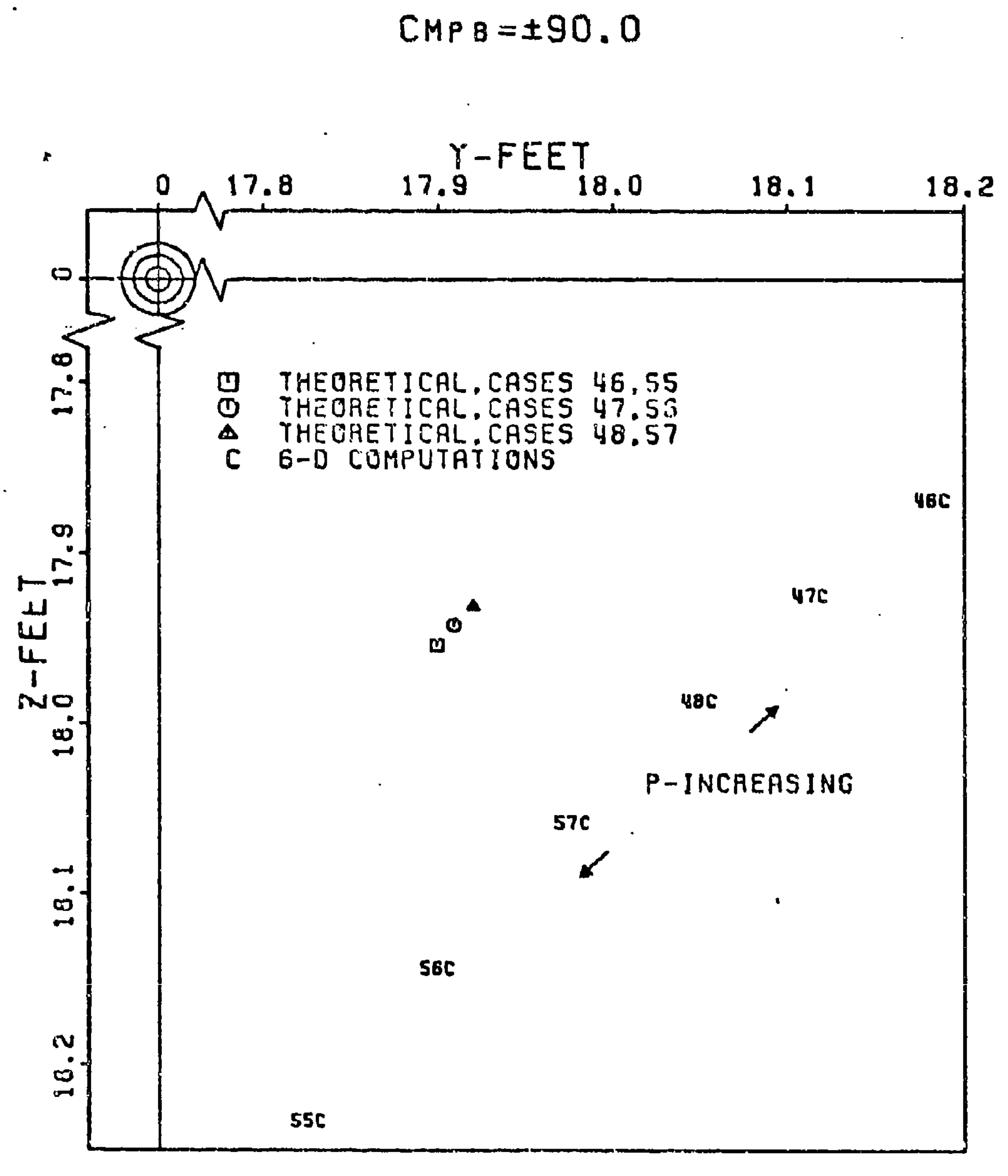


Figure 5. Dispersion: Phase II Cases 46,47,48,55,56,57

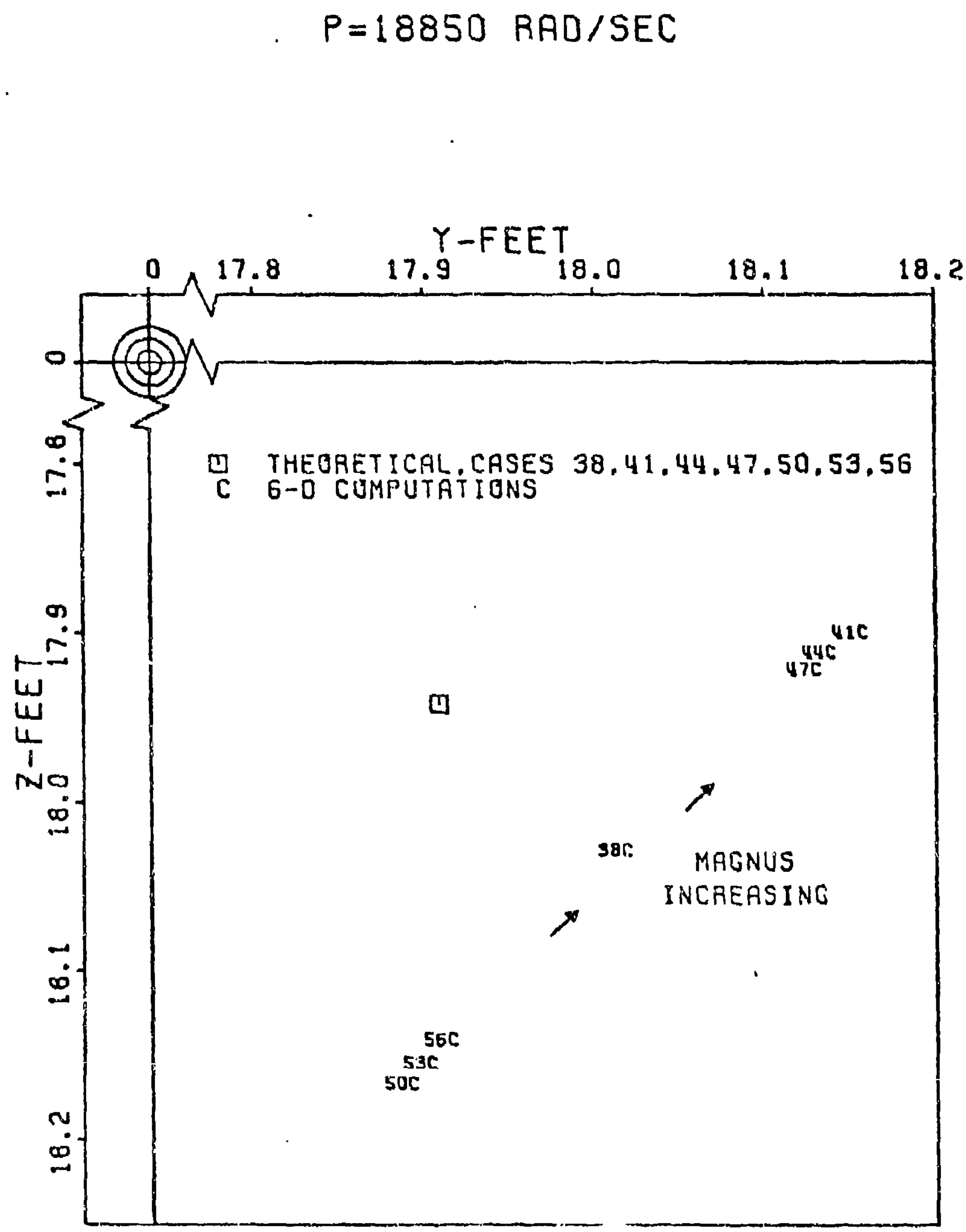


Figure 6. Dispersion: Phase II Cases 38,41,44,47,50,53,56

(for negative Magnus coefficients)

(5) decreasing horizontal dispersion with increasing p

(6) increasing vertical dispersion with increasing p

(7) decreasing horizontal dispersion with decreasing Magnus

(8) increasing vertical dispersion with decreasing Magnus

For example, Figure 5 illustrates the effects of roll rate for constant Magnus coefficients of $\pm 90^{\circ}$ (1,2,5,6 above). Figure 6 illustrates the effects of Magnus for a constant sample roll rate (3,4,7,8 above). Obviously, when only a 0.209 mil maximum deviation due to Magnus occurs when the situation is geared toward finding the largest effect due to Magnus, smaller deviations due to Magnus would be found in actual situations. It can be concluded that Magnus has no large effect on dispersion although it could be significant if the total dispersion is close to zero.

Phase III

To validate the effects of aerodynamic asymmetries on dispersion of flechettes, a large number of cases were run varying roll rate, velocity, and initial conditions while holding the asymmetry coefficients constant. The asymmetries coefficients were selected to allow 1° of non-rolling trim to exist while the flechette was in flight. The asymmetry coefficients, C_{YE}, C_{ZE}, C_{ME} and C_{NE} are presented in Appendix A-1 as a function of Mach number. The variance with Mach number was chosen arbitrarily: the ratio of asymmetry force to asymmetry moment identical to the ratio of C_{Z_α} to C_{M_α}. The wide range of roll rates makes mandatory use of all three dispersion theories. The governing equations are presented as they apply.

Cases 58-90

The first set of cases utilizes zero initial disturbances while varying velocity and roll rate. For roll rates of 31416 rad/sec down to 100 rad/sec the High Roll Rate Theory yields the governing equation,

$$\overrightarrow{J.A.} = \frac{\rho u \pi d^2}{8m}\left[C_{M_{\delta_\epsilon}}\vec{\delta_\epsilon}\left(\frac{A}{p}\right) + C_{Z_{\delta_\epsilon}}\vec{\delta_\epsilon}\left(\frac{I_y - I_x}{mud}\ A + \frac{i}{p}\right)\right] 1000$$

For roll rates: $p < 100$ rad/sec and $pt \geq 1.0$, the Low Roll Rate Theory takes effect:

$$\overrightarrow{J.A.} = \frac{\rho u^2 \pi d^2}{8mx}\left[C_{Z_{\delta_\epsilon}}\vec{\delta_\epsilon} - i\left(\frac{C_{Z_\alpha}}{C_{M_\alpha}}\right) C_{M_{\delta_\epsilon}}\vec{\delta_\epsilon}\right]\left[\frac{1}{p^2}\left(1 - \cos\frac{px}{u}\right)\right.$$

$$\left. + \frac{1}{p}\left(\frac{x}{u} - \frac{1}{p}\sin\frac{px}{u}\right)\right] 1000$$

Finally, the very Slow Roll Rate Theory applies for values of $pt < 1.0$:

$$\overrightarrow{J.A.} = \frac{\rho \pi d^2 x}{16m}\left[C_{Z_{\delta_\epsilon}}\vec{\delta_\epsilon} - i\left(\frac{C_{Z_\alpha}}{C_{M_\alpha}}\right) C_{M_{\delta_\epsilon}}\vec{\delta_\epsilon}\right]\left[\left(1 - \frac{1}{12}\left(\frac{px}{u}\right)^2 + \frac{1}{360}\left(\frac{px}{u}\right)^4\right)\right.$$

$$\left. + i\left(\frac{px}{3u} - \frac{1}{60}\left(\frac{px}{u}\right)^3 + \frac{1}{2520}\left(\frac{px}{u}\right)^5\right)\right] 1000$$

Tables 7, 8, and 9 list Cases 58-90:

TABLE VII

THEORY VALIDATION, ASYMMETRIES, CASES 58-68

CASE	Initial Conditions $\vec{\dot{S}}_o$	$\vec{\alpha}_o$	$\vec{\dot{\alpha}}_o$	p_o	u_o	Coefficients C_{Z_α}, C_{M_α}, $C_{M_q} + C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$, $C_{M_{p\beta}}$	C_{YE}, C_{ZE}, C_{ME}, C_{NE}	$\vec{J.A.}$ (mils) 6-D	Theory
58	0	0	0	31416					0.018-0.013i	0.018-0.014i
59	0	0	0	18850					0.030-0.027i	0.029-0.025i
60	0	0	0	6283					0.060-0.127i	0.064-0.130i
61	0	0	0	500					0.997-0.992i	1.013-1.009i
62	0	0	0	300					1.620-1.721i	1.688-1.683i
63	0	0	0	100	5000	A1	A1	A1	4.574-4.896i	4.675-4.975i
64	0	0	0	50					8.666-12.280i	8.780-12.489i
65	0	0	0	25					20.669-26.418i	21.150-26.927i
66	0	0	0	10					-7.973 -62.197i	-8.210 -63.210i
67	0	0	0	5					-29.857 -61.459i	-30.372 -62.353i
68	0	0	0	0					-49.706 -49.706i	-50.427 -50.427i

TABLE VIII

THEORY VALIDATION, ASYMMETRIES, CASES 69-79

CASE	Initial Conditions					Coefficients			$\overrightarrow{J.A.}$ (mils)	
	$\dot{\vec{S}}_o$	$\vec{\alpha}_o$	$\dot{\vec{\alpha}}_o$	p_o	u_o	C_{Z_α}, C_{M_α}, $C_{M_q}+C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$, $C_{M_{p\beta}}$	C_{YE}, C_{ZE}, C_{ME}, C_{NE}	6-D	Theory
69	0	0	0	31416					0.008-0.004i	0.009-0.004i
70	0	0	0	18850					0.013-0.008i	0.013-0.008i
71	0	0	0	6283					0.033-0.028i	0.034-0.029i
72	0	0	0	500					0.394-0.398i	0.401-0.396i
73	0	0	0	300					0.663-0.659i	0.666-0.662i
74	0	0	0	100	3000	A1	A1	A1	1.841-1.998i	1.994-1.984i
75	0	0	0	50					3.780-4.513i	3.411-4.164i
76	0	0	0	25					5.676-8.457i	5.721-8.516i
77	0	0	0	10					9.203-32.628i	9.217 32.897i
78	0	0	0	5					-41.029- -41.985i	-42.273i -42.273i
79	0	0	0	0					-33.014 -33.014i	-33.194 -33.194i

TABLE IX

THEORY VALIDATION, ASYMMETRIES,
CASES 80-90

CASE	Initial Conditions					Coefficients			$\overrightarrow{J.A.}$ (mils)	
	$\overrightarrow{\dot{S}}_o$	$\overrightarrow{\alpha}_o$	$\overrightarrow{\dot{\alpha}}_o$	p_o	u_o	C_{Z_α} C_{M_α} $C_{M_q}+C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$ $C_{M_{p\beta}}$	C_{YE} C_{ZE} C_{ME} C_{NE}	6-D	Theory
80	0	0	0	31416					Unstable	
81	0	0	0	18850					Unstable	
82	0	0	0	6283					0.025-0.010i	0.023-0.014i
83	0	0	0	500					0.241-0.229i	0.238-0.229i
84	0	0	0	300					0.396-0.380i	0.394-0.385i
85	0	0	0	100	1000	A1	A1	A1	1.177-1.160i	1.174-1.165i
86	0	0	0	50					2.346-2.329i	2.349-2.352i
87	0	0	0	25					4.684-4.672i	4.699-4.702i
88	0	0	0	10					10.224-14.447i	10.177-14.476i
89	0	0	0	5					24.402-31.013i	24.516-31.212i
90	0	0	0	0					-58.711-58.711i	-58.450-58.450i

Evident from Tables VII, VIII, IX is the fact that roll rate has tremendous influence on the dispersion of flechettes with aerodynamic asymmetries. Figures 7, 8, and 9 illustrate the dispersion pattern for these cases. The 6-D computations and theory are in very good agreement considering the large deviations involved. It should be noted that the actual flechette with its velocity approaching 5000 ft/sec is affected very little by aerodynamic asymmetries. However, if the flechette were only to roll very slowly, large dispersion ranges in excess of 60 mils could occur. Velocity also has a noticeable effect an dispersion. Figure 10 shows the three theory curves from Figures 7, 8, 9 in composite to illustrate velocity effects. A sample trajectory, Case 79, is shown in Figure 11, illustrating the curved path of flight. This is typical of trajectories involving aerodynamic asymmetries.

Cases 91-123

To show the relation between the effects on dispersion for initial transverse velocity and aerodynamic asymmetries a second set of cases were run. Roll rate and velocity were varied as in the first set of cases, but $\dot{\vec{S}}_o$ was set at (100 + 100i) ft/sec with $\vec{\alpha}_o = 0$ and $\dot{\vec{\alpha}}_o = 0$. Tables X, XI, and XII list the results. For high roll rate cases, Equation 24 becomes:

$$\overline{\text{J. A.}} = \left[\frac{\dot{\vec{S}}_o}{u} + \frac{\rho u \pi d^2}{8m} \left[C_{M_{\delta_\epsilon}} \vec{\delta}_\epsilon \left(\frac{A}{p} \right) + C_{Z_{\delta_\epsilon}} \vec{\delta}_\epsilon \left(\frac{I_y - I_x}{mud} A + \frac{i}{p} \right) \right] \right] 1000$$

For low rate cases, Equation 28 becomes:

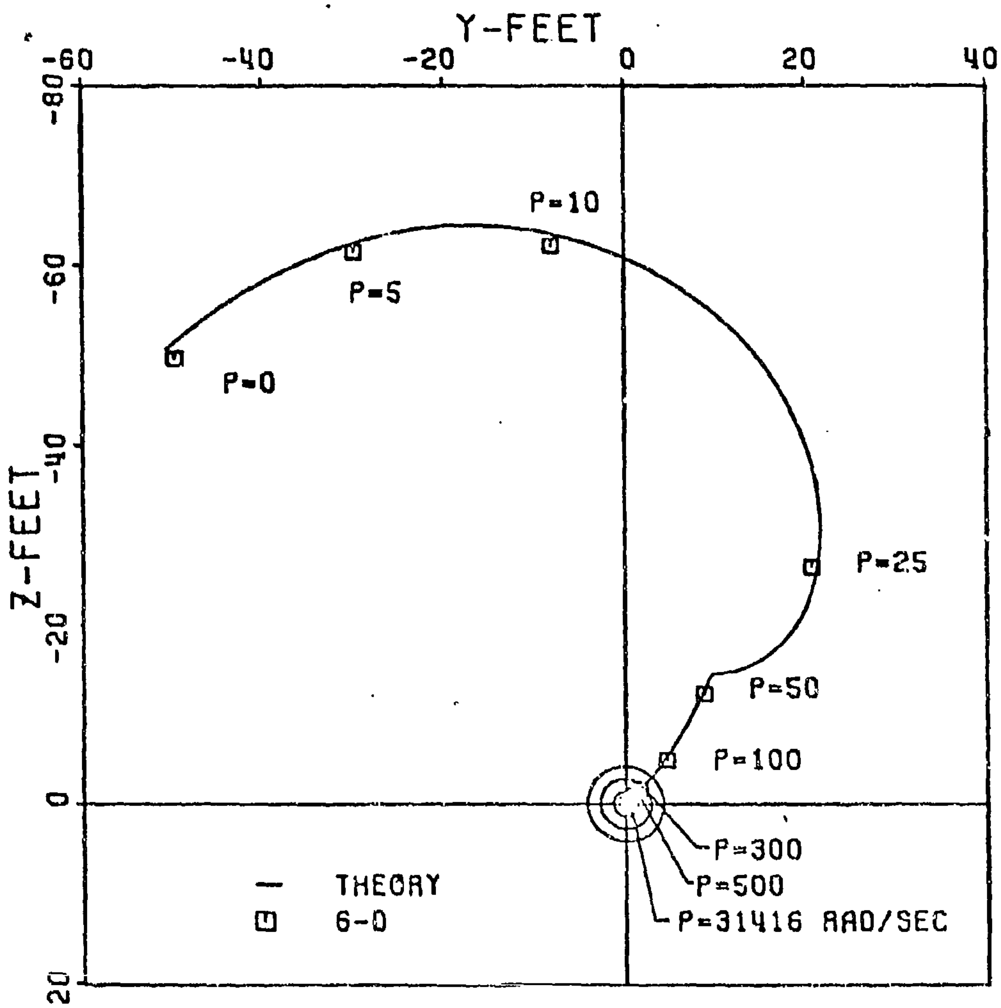


Figure 7. Dispersion: Phase III Cases 58-68

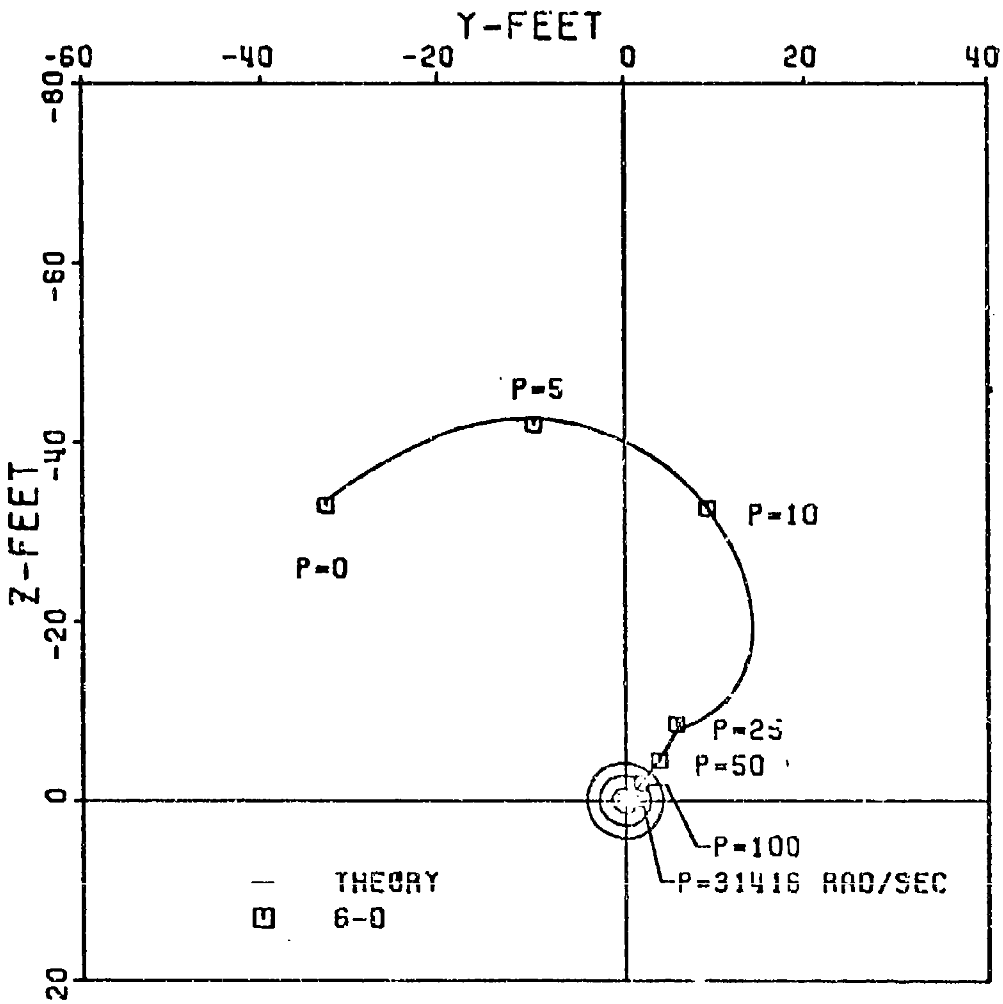


Figure 8. Dispersion: Phase III Cases 69-79

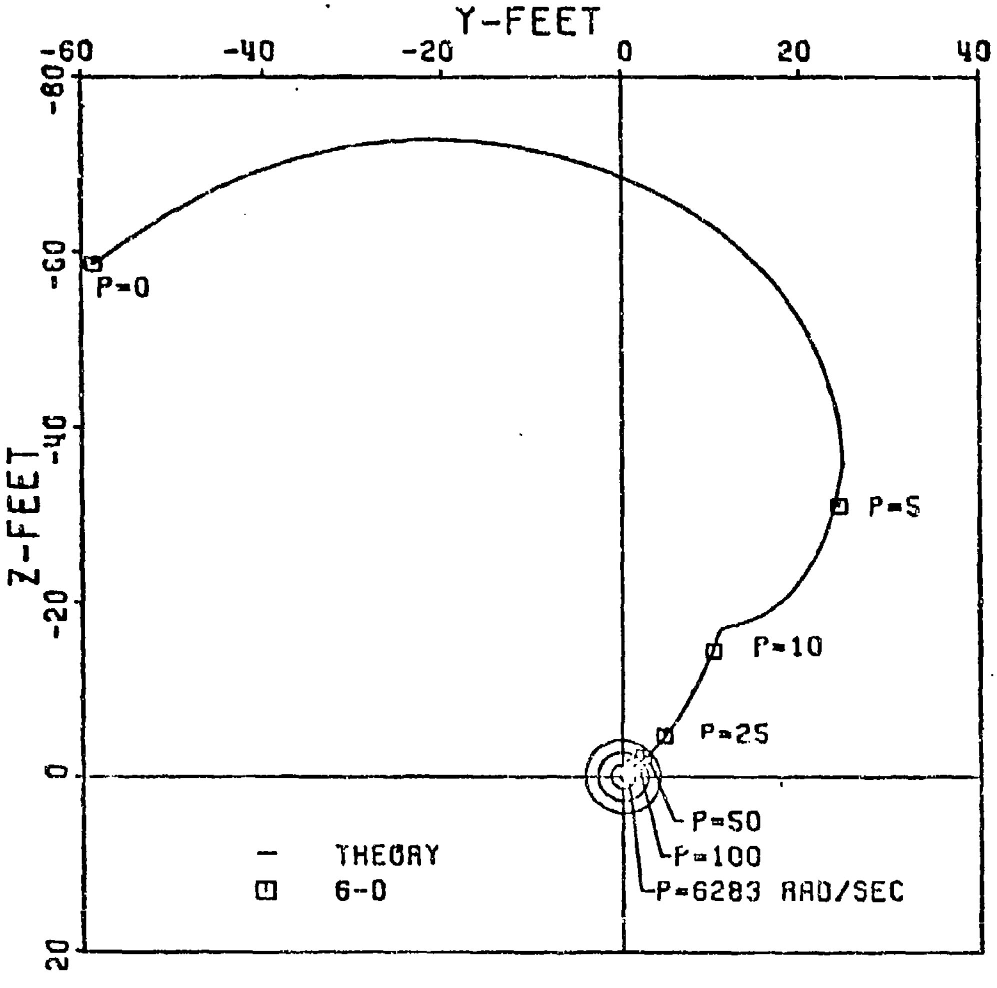


Figure 9. Dispersion: Phase III Cases 80-90

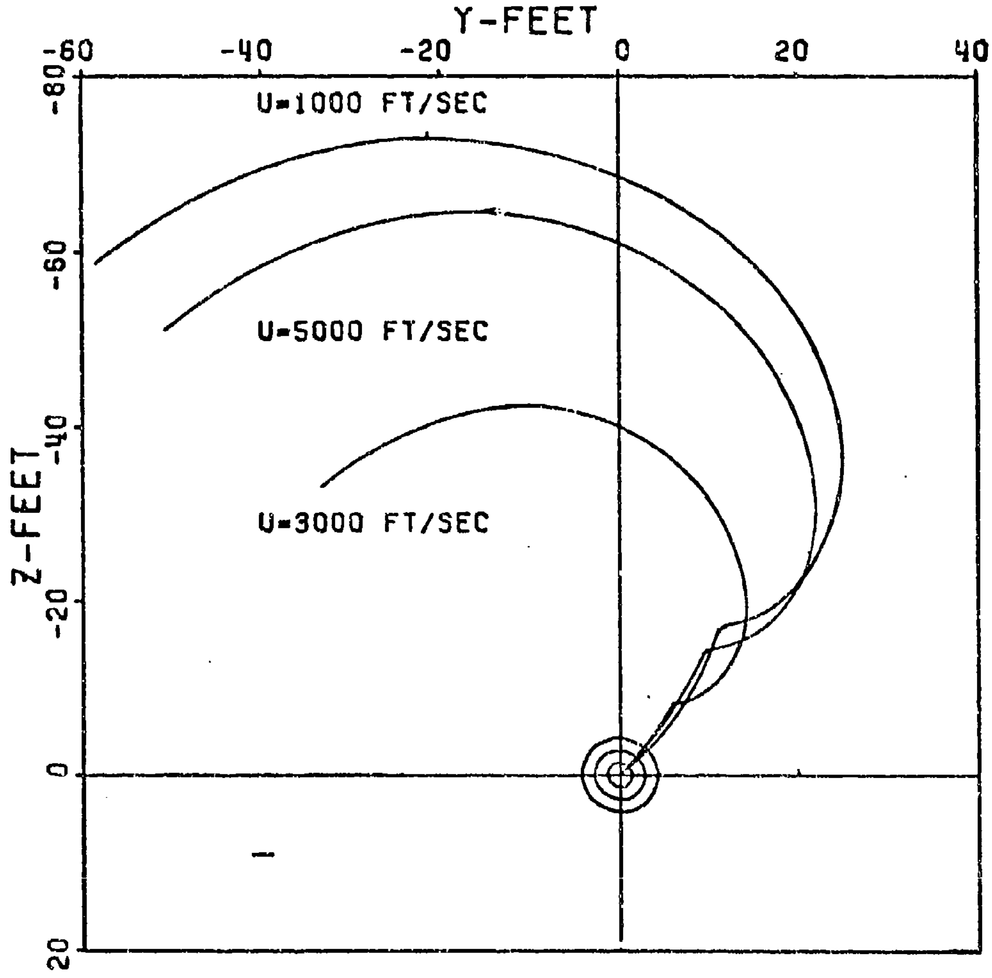


Figure 10. Dispersion: Phase III Theory, Cases 58-90

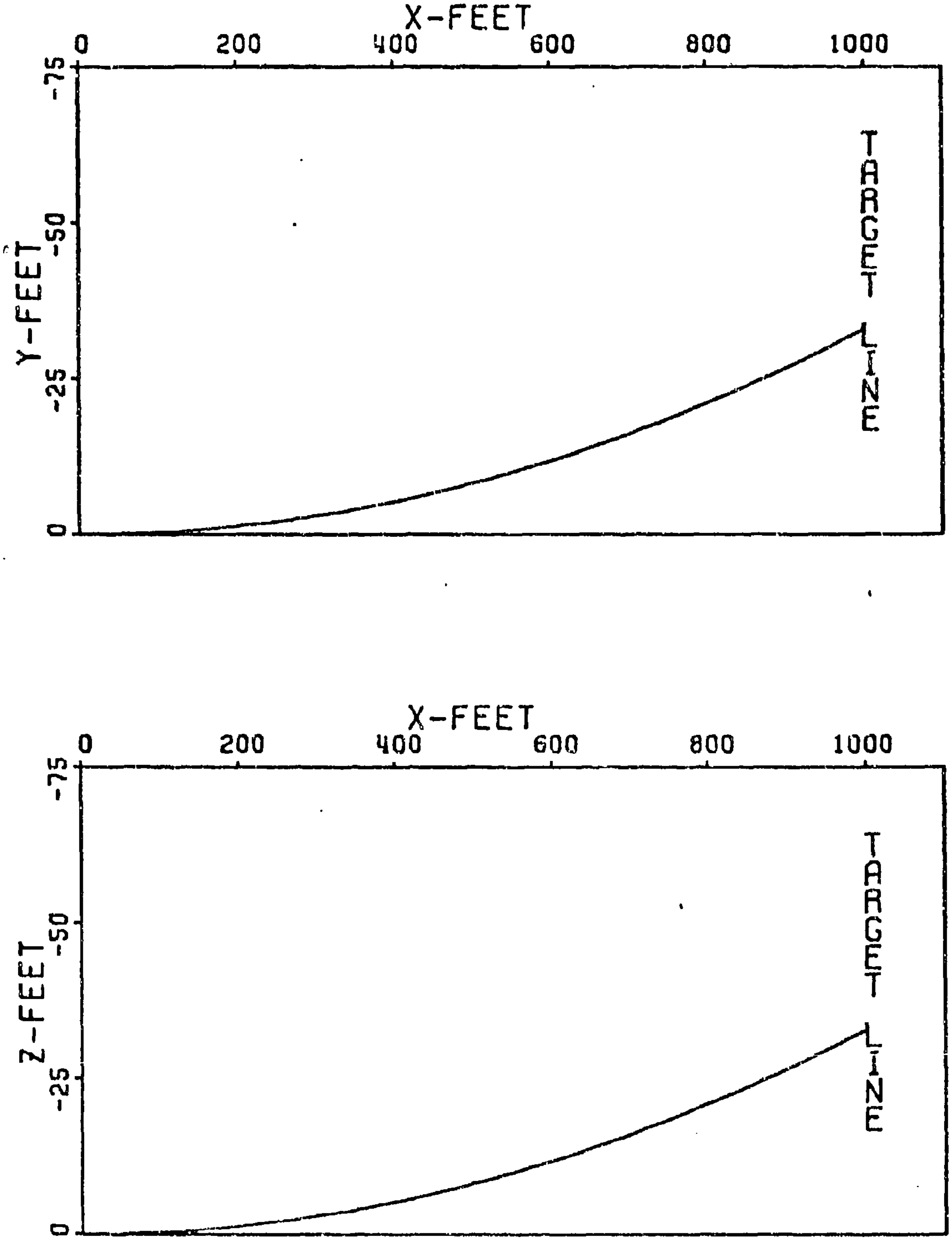


Figure 11. Trajectory, Case 79

$$\overrightarrow{J.A.} = \left[\frac{\dot{\vec{S}}_o}{u} + \frac{\rho u^2 \pi d^2}{8\,mx}\left[CZ_{\delta_\epsilon}\vec{\delta}_\epsilon - i\left(\frac{Cz_\alpha}{CM_\alpha}\right)CM_{\delta_\epsilon}\vec{\delta}_\epsilon\right]\right]\left[\frac{1}{p^2}\left(1-\cos\frac{px}{u}\right)\right.$$

$$\left.+\frac{i}{p}\left(\frac{x}{u} - \frac{1}{p}\sin\frac{px}{u}\right)\right] 1000$$

For very slow roll cases, Equation 30 becomes:

$$\overrightarrow{J.A.} = \left[\frac{\dot{\vec{S}}_o}{u} + \frac{\rho\pi d^2 x}{16m}\left[CZ_{\delta_\epsilon}\vec{\delta}_\epsilon - i\left(\frac{C_{z\alpha}}{C_{M\alpha}}\right)CM_{\delta_\epsilon}\vec{\delta}_\epsilon\right]\right]\left[\left(1 - \frac{1}{12}\left(\frac{px}{u}\right)^2\right.\right.$$

$$\left.\left.+\frac{1}{360}\left(\frac{px}{u}\right)^4\right) + i\left(\frac{px}{3u} - \frac{1}{60}\left(\frac{px}{u}\right)^3 + \frac{1}{2520}\left(\frac{px}{u}\right)^5\right)\right]1000$$

Comparing Cases 91,92, 93 in Table X with Cases 10,11,12 in Table II and Cases 58,59,60 in Table VII it can be concluded that; except for possible computational error, Cases 91,92 and 93 are the algebraic sum of Cases 10,11,12 and 58,59,60; that is, for example, Case 91 equals Case 10 plus Case 58. This fact is obviously true of the theory equations and is here shown to be the case for the 6-D computations as well. Similar comparisons can be made with corresponding cases in Tables II, VIII, XI and II, IX, XII. Thus, the effects of aerodynamic asymmetries and those of initial transverse velocity are independent of one another.

Figures 12,13 and 14 illustrate the Cases 91-123. The curves are of the same form as Figures 7,8 and 9 but differ with the addition of $\dot{\vec{S}}_o$. Maximum effect of all parameters is desired. Cases 113, 114 and 115 show the limit of parameter combinations by 113 and 114 going unstable. Roll rate effects are again large and velocity effects are larger than in Cases 58-90. Figure 15 shows this to be true and also shows the cases involving

TABLE X

THEORY VALIDATION, ASYMMETRIES, CASES 91-101

CASE	Initial Conditions					Coefficients			$\overrightarrow{J.A.}$ (mils)	
	$\vec{S}_o$	$\vec{\alpha}_o$	$\vec{\dot{\alpha}}_o$	p_o	u_o	C_{Z_α} C_{M_α} $C_{M_q} + C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$ $C_{M_{p\beta}}$	C_{YE} C_{ZE} C_{ME} C_{NE}	6-D	Theory
91				31416					20.011+ 19.987i	20.018+ 19.986i
92				18850					20.026+ 19.972i	20.029+ 19.975i
93				6283					20.056+ 19.872i	20.083+ 19.922i
94				500					21.004+ 19.012i	21.013+ 18.991i
95				300					21.626+ 18.286i	21.688+ 18.317i
96	100+ 100i	0	0	100	5000	A1	A1	A1	24.593+ 15.099i	24.675+ 15.025i
97				50					28.702+ 7.687i	28.780+ 7.511i
98				25					40.766- 6.492i	41.150- 6.927i
99				10					11.983- 42.325i	11.790- 43.210i
100				5					-9.908- 41.503i	-10.372 -42.353i
101				0					-29.727 -29.743i	-30.427 -30.427i

TABLE XI

THEORY VALIDATION, ASYMMETRIES, CASES 102-112

CASE	Initial Conditions					Coefficients			$\overrightarrow{J.A.}$ (mils)	
	$\vec{\dot{S}}_o$	$\vec{\alpha}_o$	$\vec{\dot{\alpha}}_o$	p_o	u_o	C_{Z_α}, C_{M_α}, $C_{M_q}+C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$, $C_{M_{p\beta}}$	C_{YE}, C_{ZE}, C_{ME}, C_{NE}	6-D	Theory
102	100+100i	0	0	31416	3000	A1	A1	A1	33.352+ 33.362i	33.342+ 33.329i
103	100+100i	0	0	18850	3000	A1	A1	A1	33.366+ 33.364i	33.345+ 33.325i
104	100+100i	0	0	6283	3000	A1	A1	A1	33.388+ 33.347i	33.367+ 33.304i
105	100+100i	0	0	500	3000	A1	A1	A1	33.740+ 32.964i	33.734+ 32.937i
106	100+100i	0	0	300	3000	A1	A1	A1	34.009+ 33.705i	34.000+ 32.761i
107	100+100i	0	0	100	3000	A1	A1	A1	35.188+ 31.361i	35.327+ 31.344i
108	100+100i	0	0	50	3000	A1	A1	A1	37.139+ 28.850i	36.744+ 29.169i
109	100+100i	0	0	25	3000	A1	A1	A1	39.029+ 24.892i	39.054+ 24.817i
110	100+100i	0	0	10	3000	A1	A1	A1	42.575+ 0.716i	42.550+ 0.436i
111	100+100i	0	0	5	3000	A1	A1	A1	23.312- 8.612i	23.159- 8.940i
112	100+100i	0	0	0	3000	A1	A1	A1	0.380+ 0.362i	0.139+ 0.139i

TABLE XII

THEORY VALIDATION, ASYMMETRIES, CASES 113-123

CASE	Initial Conditions					Coefficients			J. A. (mils)	
	$\vec{\dot{S}}_o$	$\vec{\alpha}_o$	$\vec{\dot{\alpha}}_o$	p_o	u_o	C_{Z_α}, C_{M_α}, $C_{M_q} + C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$, $C_{M_{p\beta}}$	C_{YE}, C_{ZE}, C_{ME}, C_{NE}	6-D	Theory
113				31416					Unstable	
114				18850					Unstable	
115				6283					100.351+ 100.814i	100.023+ 99.986i
116				500					100.559+ 100.587i	100.238+ 99.771i
117				300					100.710+ 100.431i	100.394+ 99.615i
118	100+ 100i	0	0	100	1000	A1	A1	A1	101.492+ 99.658i	101.174+ 98.835i
119				50					102.668+ 98.495i	102.349+ 97.648i
120				25					105.019+ 96.164i	104.699+ 95.298i
121				10					110.862+ 86.275i	110.177+ 85.524i
122				5					125.216+ 69.958i	124.516+ 68.788i
123				0					41.499+ 41.413i	41.550+ 41.550i

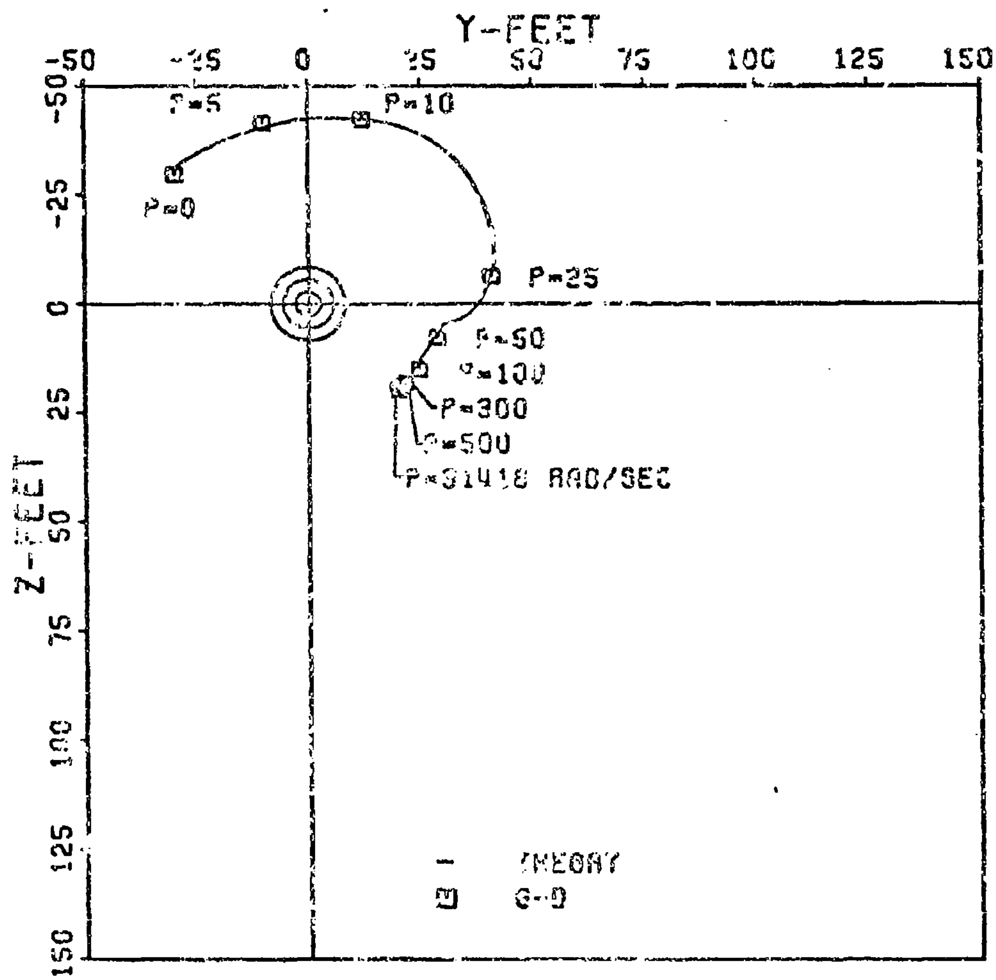


Figure 12. Dispersion; [illegible]e III Cases 91-[illegible]

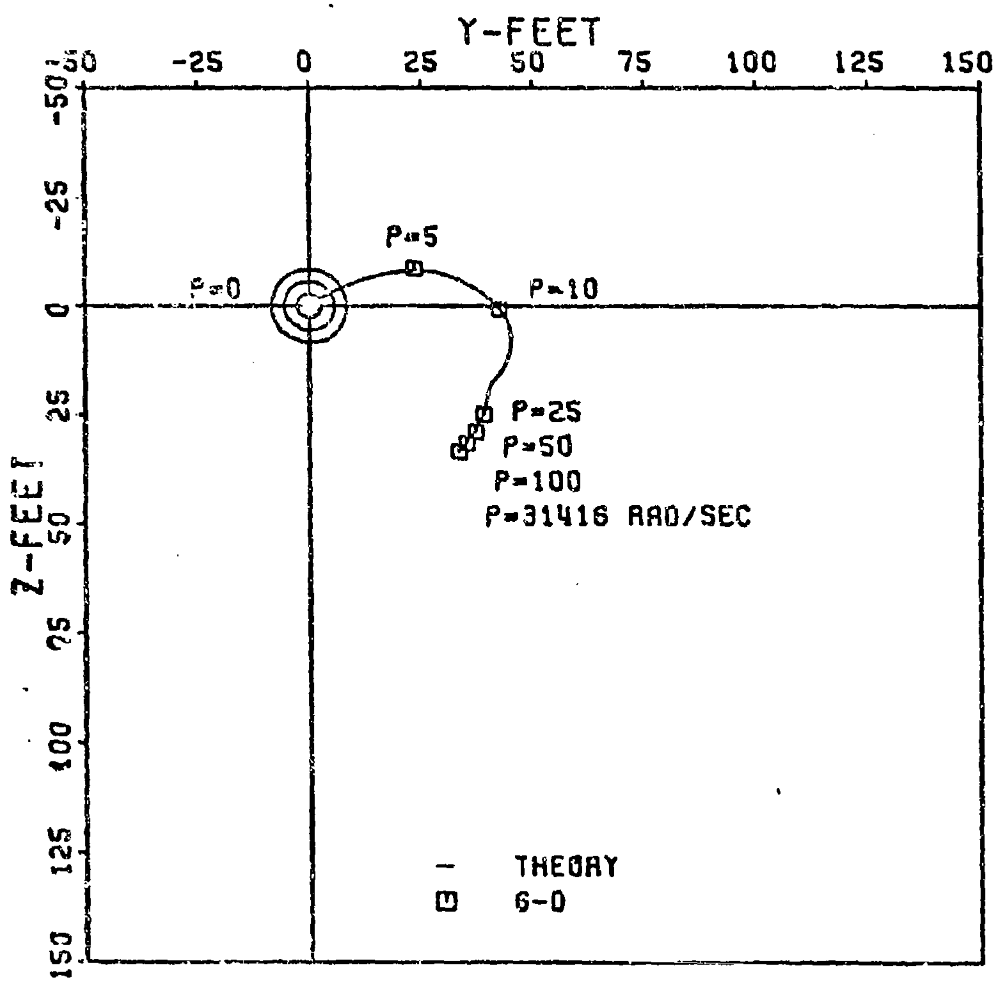


Figure 13. Dispersion: Phase III Cases 102-112

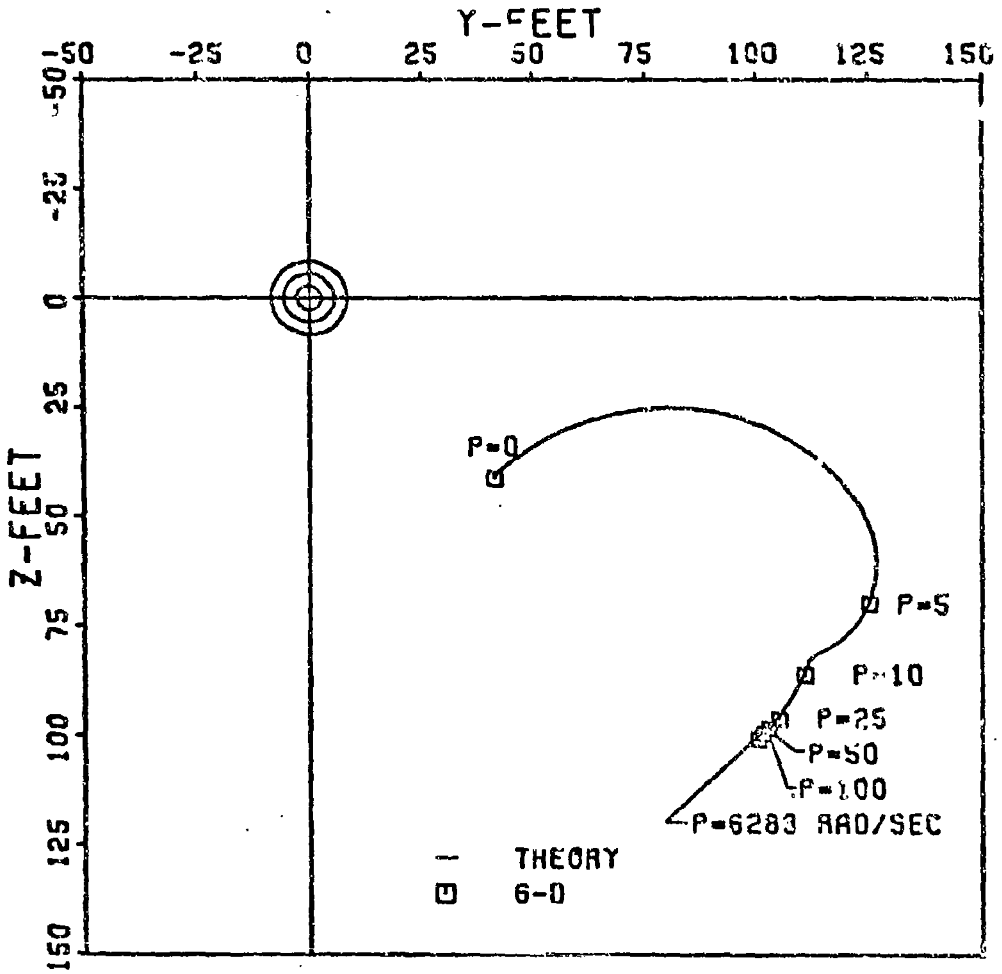


Figure 14. Dispersion: Phase III Cases 113-123

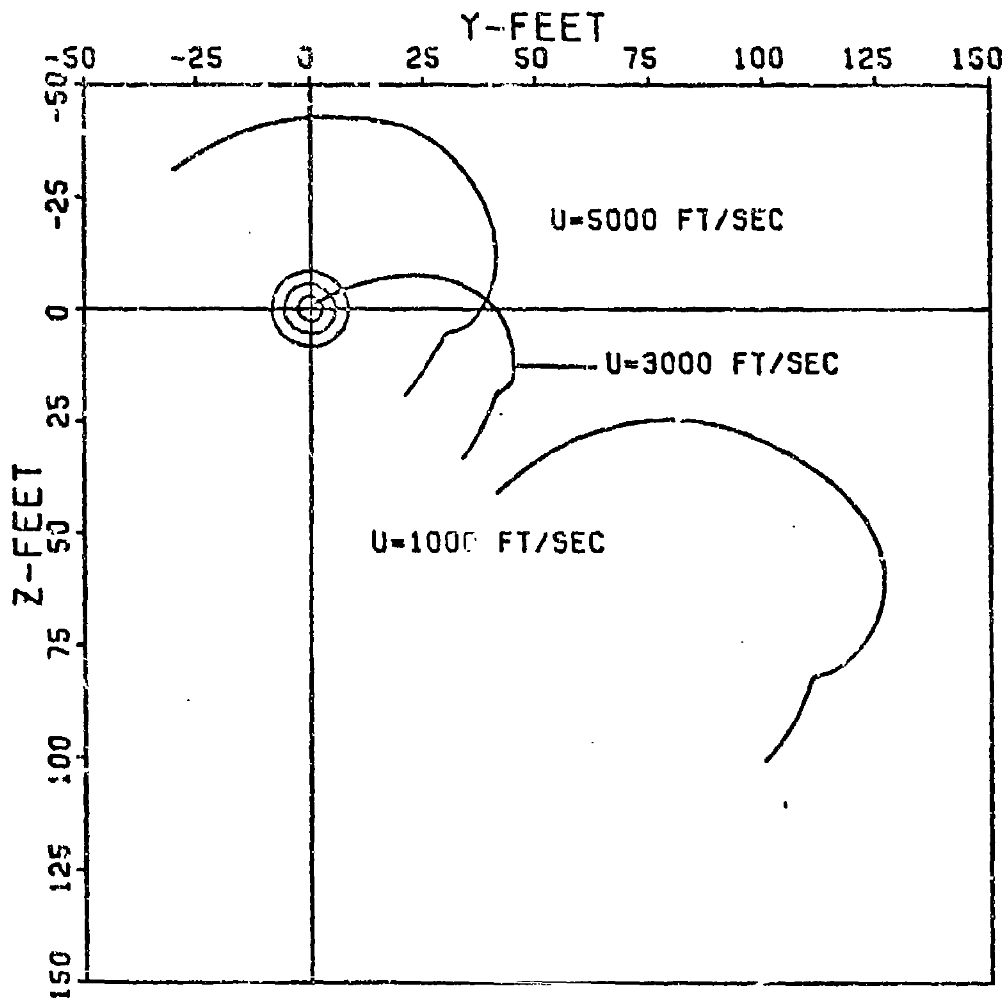


Figure 15. Disp rsion: Phase III Theory, Cases 91-123

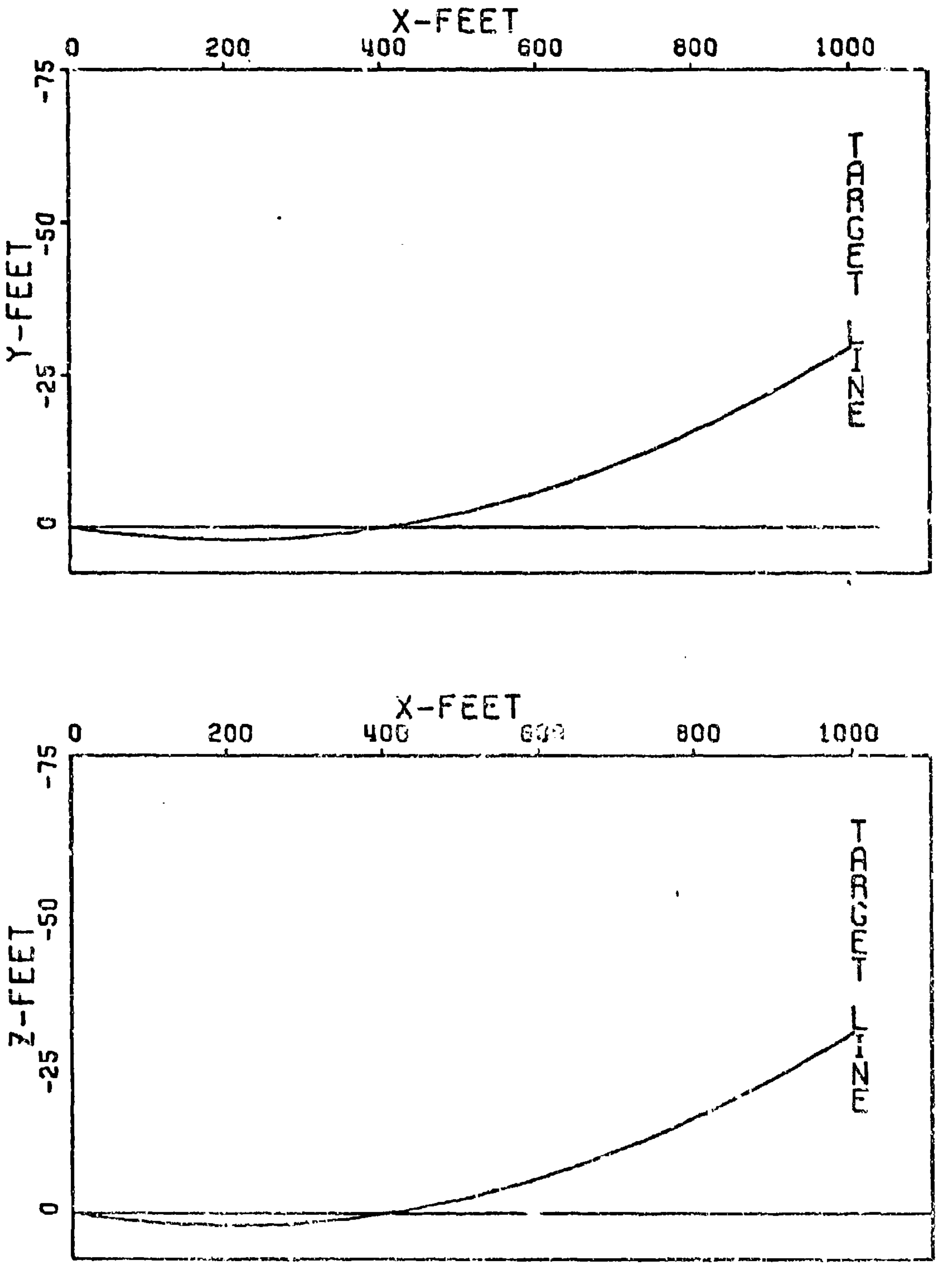


Figure 16. Trajectory, Case 101

U = 3000 ft/sec to be ones of smallest dispersion. Such was the case in Figure 10. Figure 16 illustrates a sample trajectory, Case 101.

Cases 124-156

To establish the relationship between the effects on dispersion for aerodynamic asymmetries and initial angle of attack, a third set of cases were run. Again roll rate and velocity were varied as done previously but $\vec{\alpha}_o$ was set at (1+i) degrees with $\vec{\dot{S}}_o = 0$ and $\dot{\vec{\alpha}}_o = 0$. Tables XIII, XIV, and XV tabulate the results. For all high roll rate cases, Equation 24 reduces to:

$$\overrightarrow{J.A.} = \left[\frac{ipI_x}{mud} A\vec{\alpha}_o + \frac{\rho u \pi d^2}{8m}\left[C_{M_{\delta_\epsilon}}\vec{\delta}_\epsilon\left(\frac{A}{p}\right) + C_{Z_{\delta_\epsilon}}\vec{\delta}_\epsilon\left(\frac{I_y - I_x}{mud} A + \frac{i}{p}\right)\right]\right] 1000$$

For low roll rate cases, Equation 28 reduces to:

$$\overrightarrow{J.A.} = \frac{\rho u^2 \pi d^2}{8mx}\left[C_{Z_{\delta_\epsilon}}\vec{\delta}_\epsilon - i\left(\frac{C_{Z_\alpha}}{C_{M_\alpha}}\right)C_{M_{\delta_\epsilon}}\vec{\delta}_\epsilon\right]\left[\frac{1}{p^2}\left(1 - \cos\frac{px}{u}\right) + \frac{i}{p}\left(\frac{x}{u} - \frac{1}{p}\sin\frac{px}{u}\right)\right] 1000$$

For very low roll rates, Equation 30 reduces to:

$$\overrightarrow{J.A.} = \frac{\rho \pi d^2 x}{16m}\left[C_{Z_{\delta_\epsilon}}\vec{\delta}_\epsilon - i\left(\frac{C_{Z_\alpha}}{C_{M_\alpha}}\right)C_{M_{\delta_\epsilon}}\vec{\delta}_\epsilon\right]\left[\left(1 - \frac{1}{12}\left(\frac{px}{u}\right)^2 + \frac{1}{360}\left(\frac{px}{u}\right)^4\right) + i\left(\frac{px}{3u} - \frac{1}{60}\left(\frac{px}{u}\right)^3 + \frac{1}{2520}\left(\frac{px}{u}\right)^5\right)\right] 1000$$

Only for high roll rates does the $\vec{\alpha}_o$ term appear. $\vec{\alpha}_o$ should have no noticeable effect on dispersion for p < 100 rad/sec.

TABLE XIII

THEORY VALIDATION, ASYMMETRIES, CASES 124-134

CASE	Initial Conditions					Coefficients			$\overrightarrow{J.A.}$ (mils)	
	$\vec{S}_o$	$\vec{\alpha}_o$	$\vec{\dot{\alpha}}_o$	p_o	u_o	C_{Z_α} C_{M_α} $C_{M_q}+C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$ $C_{M_{p\beta}}$	C_{YE} C_{ZE} C_{ME} C_{NE}	6-D	Theory
124				31416					0.028+ 0.052i	0.009- 0.013i
125				18850					0.052+ 0.029i	0.013- 0.009i
126				6283					0.094- 0.080i	0.078- 0.073i
127				500					1.040- 0.954i	1.013- 1.009i
128				300					1.660- 1.680i	1.688- 1.683i
129	0	1+i	0	100	5000	A1	A1	A1	4.628- 4.868i	4.675- 4.975i
130				50					8.732- 12.279i	8.780- 12.489i
131				25					20.784- 26.468i	21.150- 26.927i
132				10					-7.954- 62.367i	-8.210- 63.210i
133				5					-29.912 -61.629i	-30.372 -62.353i
134				0					-49.828 -49.840i	-50.427 -50.427i

TABLE XIV

THEORY VALIDATION, ASYMMETRIES, CASES 135-145

CASE	Initial Conditions					Coefficients			$\overrightarrow{J.A.}$ (mils)	
	$\vec{\dot{S}}_o$	$\vec{\alpha}_o$	$\vec{\dot{\alpha}}_o$	p_o	u_o	C_{Z_α} C_{M_α} $C_{M_q}+C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$ $C_{M_{p\beta}}$	C_{YE} C_{ZE} C_{ME} C_{NE}	6-D	Theory
135				31416					Unstable	
136				18850					0.035+ 0.046i	-0.003 +0.008i
137				6283					0.066+ 0.017i	0.029- 0.024i
138				500					0.432- 0.357i	0.401- 0.396i
139				300					0.701- 0.618i	0.666- 0.662i
140	0	1+i	0	100	3000	A1	A1	A1	1.879- 1.958i	1.994- 1.989i
141				50					3.819- 4.473i	3.411- 4.164i
142				25					5.714- 8.416i	5.721- 8.516i
143				10					9.247- 32.586i	9.217- 32.897i
144				5					-9.985- 41.948i	-10.174 -42.273i
145				0					-32.973 -32.981i	-33.194 -33.194i

TABLE XV

THEORY VALIDATION, ASYMMETRIES, CASES 146-156

CASE	Initial Conditions					Coefficients			$\vec{J.A.}$ (mils)	
	$\vec{S}_o$	$\vec{\alpha}_o$	$\dot{\vec{\alpha}}_o$	p_o	u_o	$C_{Z\alpha}$, $C_{M\alpha}$, $C_{M_q}+C_{M\dot{\alpha}}$	$C_{Z_{p\beta}}$, $C_{M_{p\beta}}$	C_{YE}, C_{ZE}, C_{ME}, C_{NE}	6-D	Theory
146				31416					Unstable	
147				18850					Unstable	
148				6283					0.046+ 0.039i	0.008+ 0.001i
149				500					0.275- 0.188i	0.237- 0.228i
150				300					0.432- 0.342i	0.393- 0.384i
151	0	1+i	0	100	1000	A1	A1	A1	1.213- 1.123i	1.174- 1.165i
152				50					2.381- 2.294i	2.349- 2.352i
153				25					4.719- 4.637i	4.699- 4.702i
154				10					10.258- 14.411i	10.177- 14.476i
155				5					24.440- 30.976i	24.516- 31.212i
156				0					-58.669 -58.684i	-58.450 -58.450i

Comparing Cases 124, 125, 126 in Table XIII with Cases 19, 20, 21 in Table III and Cases 58, 59, 60 in Table VII it can be concluded that Cases 124, 125 and 126 are the algebraic sum of Cases 19, 20, 21 and 58, 59, 60; that is, for example, Case 124 equals Case 19 plus Case 58. This is obvious from the reduced theoretical equations for Cases 124-156. It is shown here to be also true for the 6-D computations; allowing for some computational error. Similar comparisons can be made with corresponding cases in Tables III, VIII, XIV and III, IX, XV. Thus the effects of aerodynamic asymmetries and those of initial angle of attack are independent of one another.

Figures 17, 18 and 19 illustrate Cases 124-156. The curves are very similar to those in Figures 7, 8, and 9 with the only difference being the very small $\vec{\alpha}_o$ contribution in Figures 17, 18, and 19. Cases 135, 146, and 147 result in instabilities, indicating that maximum effect of the various parameters has been accomplished. Effects of roll rate are essentially the same as in Case 58-90 and effects of velocity, Figure 20, the same as in Figure 10. Cases with U = 3000 ft/sec again have the smallest dispersion. Figure 21 shows a typical trajectory, Case 134.

Cases 157-189

To validate the relationship between the effects on dispersion for aerodynamic asymmetries and those of initial angular rate, a fourth set of cases were run. As before, roll rate and velocity were varied, but $\dot{\vec{\alpha}}_o$ set at (250 + 250i) rad/sec with $\vec{S}_o = 0$ and $\vec{\alpha}_o = 0$. Tables XVI, XVII,

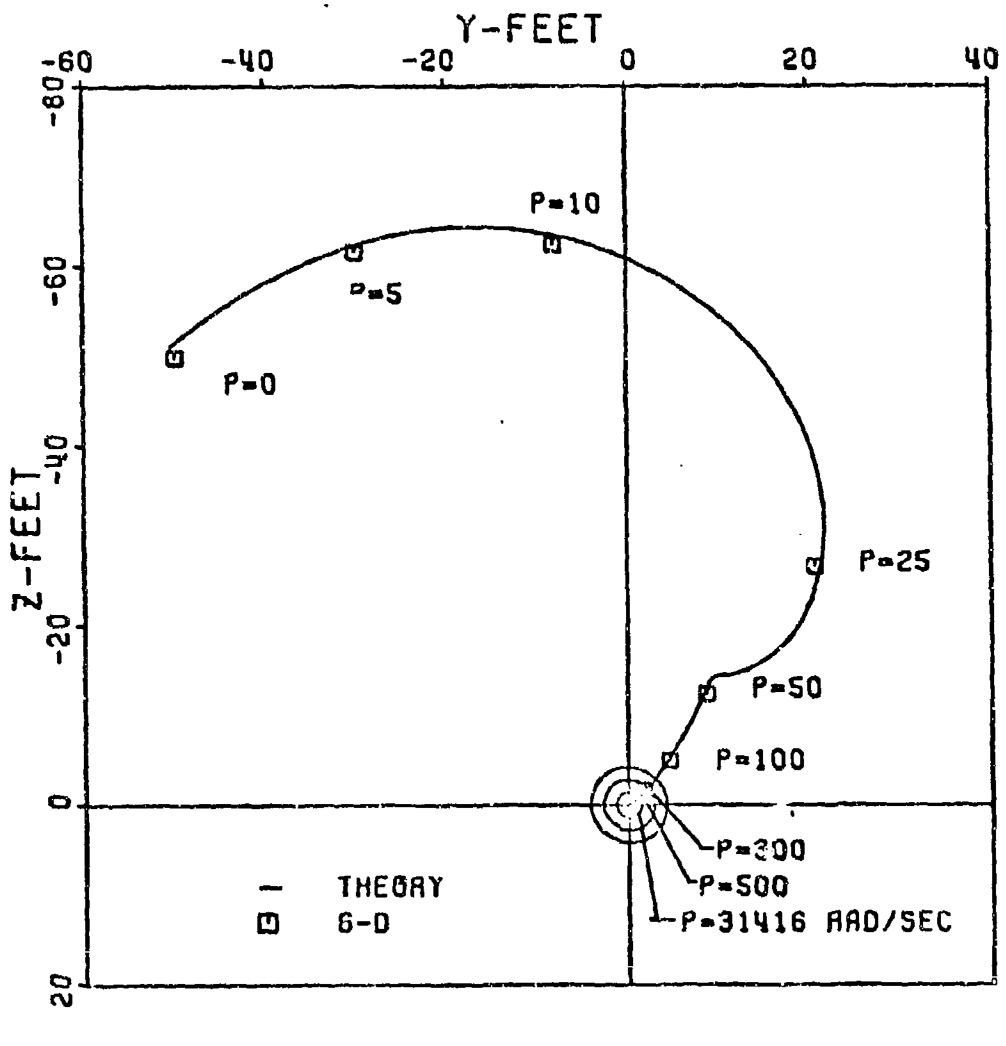


Figure 17. Dispersion: Phase III Cases 124-134

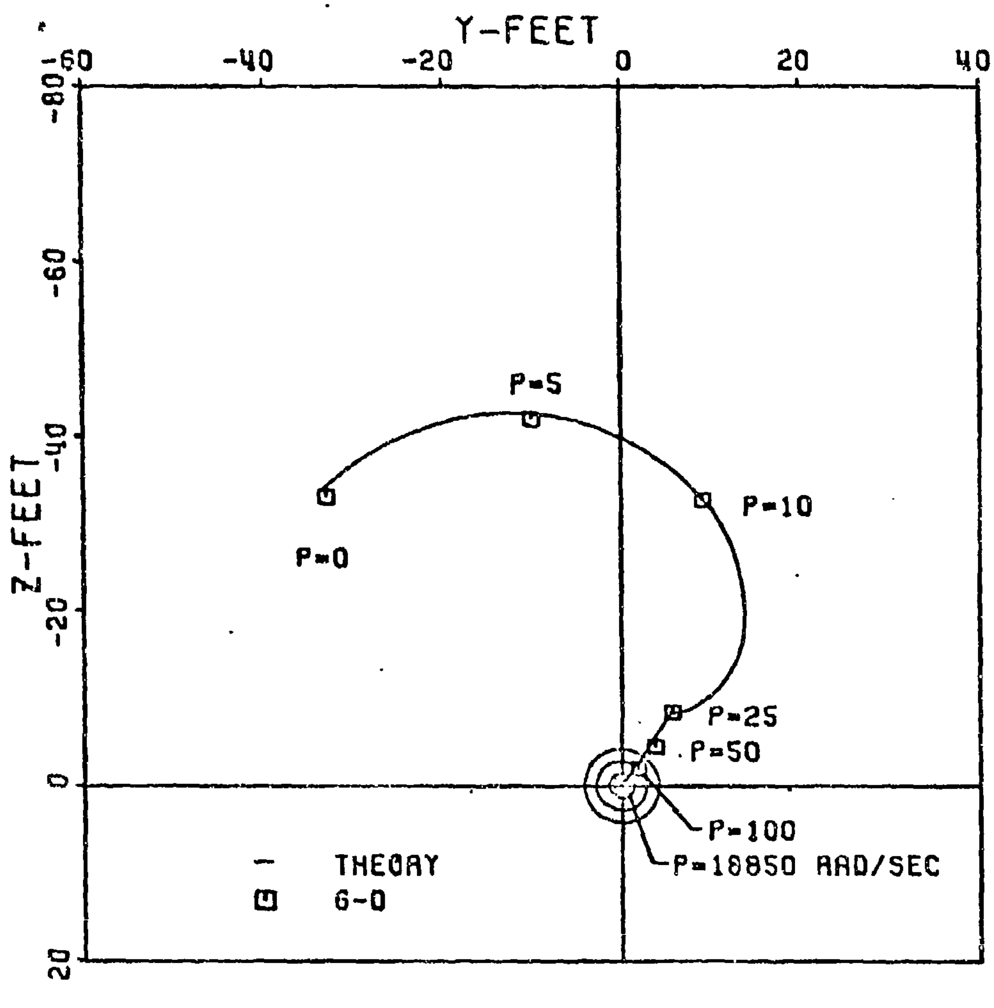


Figure 18. Dispersion: Phase III Cases 135-145

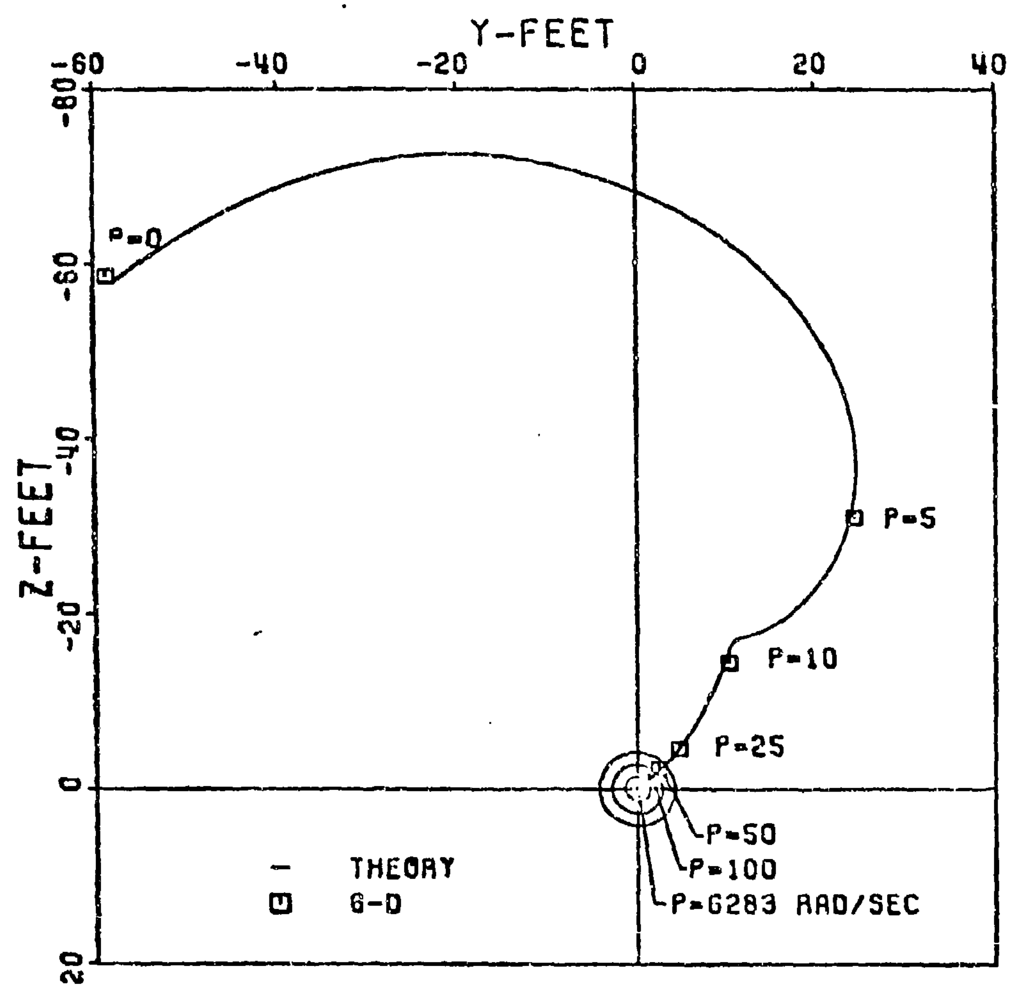


Figure 19. Dispersion: Phase III Cases 146-156

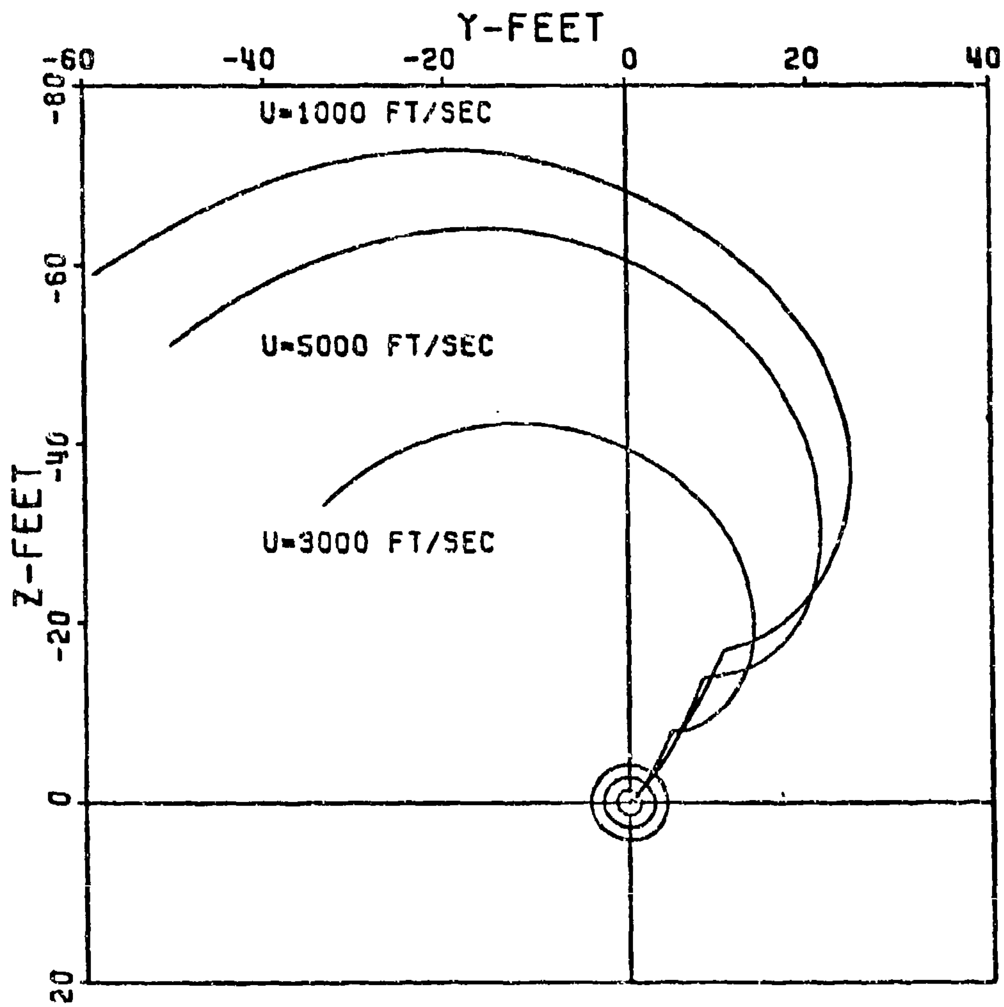


Figure 20. Dispersion: Phase III Theory, Cases 124-156

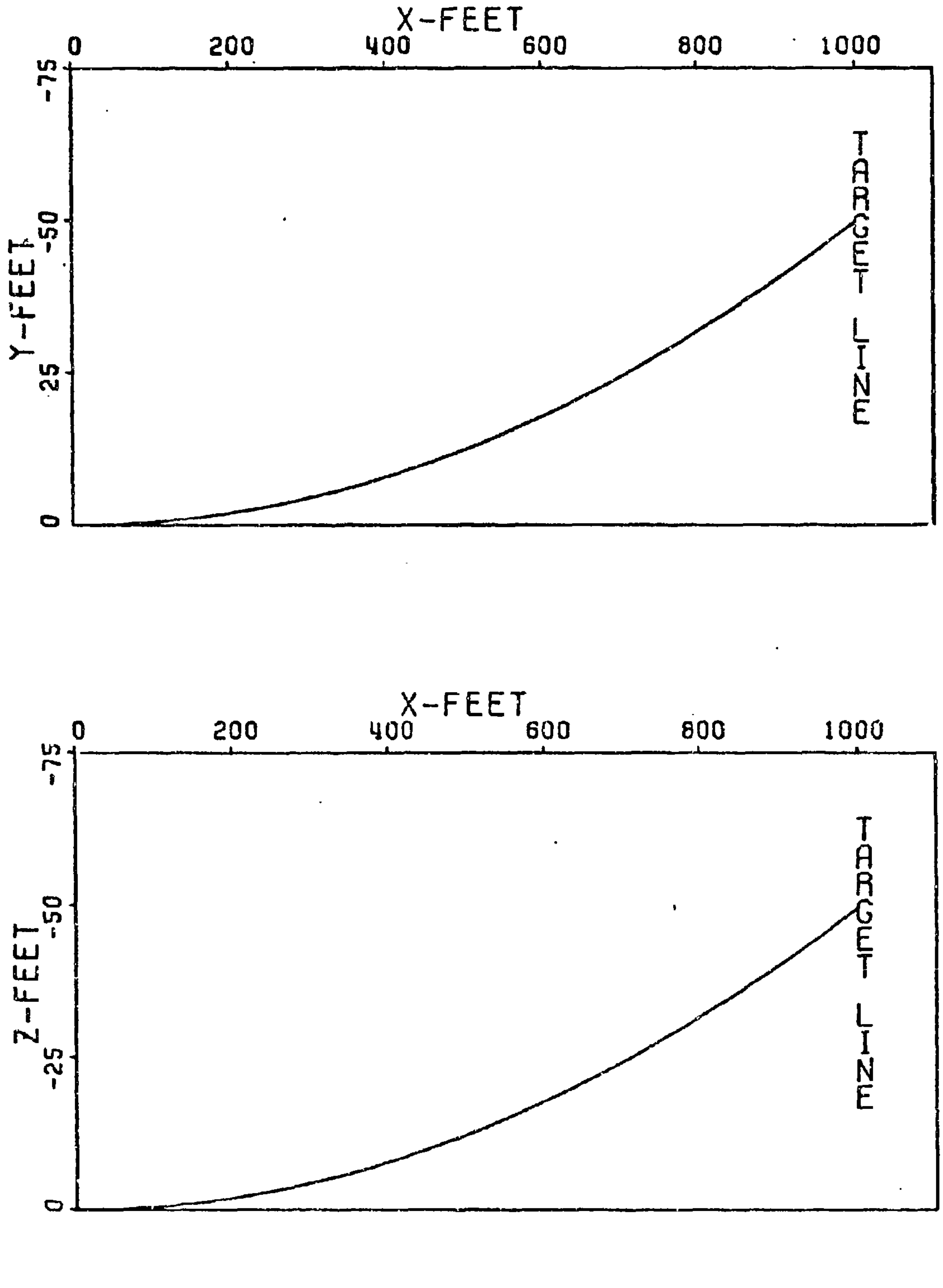


Figure 21. Trajectory, Case 134

XVIII gives the results. For high roll rates, the governing equation becomes:

$$\overrightarrow{J.A.} = \left[\frac{\rho u \pi d^2}{8m} \left[C_{M_{\delta_\epsilon}} \vec{\delta}_\epsilon \left(\frac{A}{p} \right) + C_{Z_{\delta_\epsilon}} \vec{\delta}_\epsilon \left(\frac{I_y - I_x}{mud} A + \frac{i}{p} \right) \right] - \frac{I_y}{mud} A \vec{\dot{\alpha}}_o \right] 1000$$

For low roll rates, the governing equation:

$$\overrightarrow{J.A.} = \left[\frac{\rho u^2 \pi d^2}{8\, mx} \left[C_{Z_{\delta_\epsilon}} \vec{\delta}_\epsilon - i \left(\frac{C_{Z_\alpha}}{C_{M_\alpha}} \right) C_{M_{\delta_\epsilon}} \vec{\delta}_\epsilon \right] \left[\left(1 - \cos \frac{px}{u} \right) + \frac{i}{p} \left(\frac{x}{u} - \frac{1}{p} \sin \frac{px}{u} \right) \right] - \frac{I_y}{mud} \left(\frac{C_{Z_\alpha}}{C_{M_\alpha}} \right) \vec{\dot{\alpha}}_o \right] 1000$$

For very slow roll, the governing equation:

$$\overrightarrow{J.A.} = \left[\frac{\rho \pi d^2 x}{16m} \left[C_{Z_{\delta_\epsilon}} \vec{\delta}_\epsilon - i \left(\frac{C_{Z_\alpha}}{C_{M_\alpha}} \right) C_{M_{\delta_\epsilon}} \vec{\delta}_\epsilon \right] \left[\left(1 - \frac{1}{12} \left(\frac{px}{u} \right)^2 + \frac{1}{360} \left(\frac{px}{u} \right)^4 \right) + i \left(\frac{px}{3u} - \frac{1}{60} \left(\frac{px}{u} \right)^3 + \frac{1}{2520} \left(\frac{px}{u} \right)^5 \right) \right] - \frac{I_y}{mud} \left(\frac{C_{Z_\alpha}}{C_{M_\alpha}} \right) \vec{\dot{\alpha}}_o \right] 1000$$

Comparing Cases 157, 158, 159 in Table XVI with Cases 28, 29, 30 in Table IV and Cases 58, 59, 60 in Table VII, it can be concluded that Cases 157, 158, and 159 are the algebraic sum of Cases 28, 29, 30 and 58, 59, 60; that is, for example, Case 157 equals Case 28 plus Case 58. This is obvious from the reduced theoretical equations for Cases 157-189. Here it is shown to be true for 6-D computations also. Any discrepancy can be attributed to computational error. Similar comparisons can be made with corresponding cases in Table IV, VIII, and XVII. Thus the effects of aerodynamic asymmetries and those of initial angular rate are independent of one another.

TABLE XVI

THEORY VALIDATION, ASYMMETRIES, CASES 157-167

CASE	Initial Conditions $\vec{\dot{S}}_o$	$\vec{\alpha}_o$	$\vec{\dot{\alpha}}_o$	p_o	u_o	Coefficients C_{Z_α}, C_{M_α}, $C_{M_q}+C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$, $C_{M_{p\beta}}$	C_{YE}, C_{ZE}, C_{ME}, C_{NE}	$\vec{J.A.}$ (mils) 6-D	Theory
157				31416					-1.799 -2.236i	-2.055 -2.087i
158				18850					-1.873 -2.169i	-2.044 -2.098i
159				6283					-1.924 -2.190i	-1.990 -2.151i
160				500					-1.049 -3.000i	-1.060 -3.082i
161				300					-0.419 -3.716i	-0.385 -3.756i
162	0	0	250+250i	100	5000	A1	A1	A1	2.457-6.836i	2.602-7.048i
163				50					6.576-14.075i	6.707-14.562i
164				25					18.366-27.827i	19.077-29.000i
165				10					-9.690-63.387	-10.283 -65.283i
166				5					-31.387 -62.730i	-32.445 -64.426i
167				0					-51.094 -51.094i	-52.500 -52.500i

TABLE XVII

THEORY VALIDATION, ASYMMETRIES, CASES 168-178

CASE	Initial Conditions					Coefficients			$\overrightarrow{J.A.}$ (mils)	
	$\vec{\dot{S}}_o$	$\vec{\alpha}_o$	$\vec{\dot{\alpha}}_o$	p_o	u_o	C_{Z_α} C_{M_α} $C_{M_q}+C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$ $C_{M_{p\beta}}$	C_{YE} C_{ZE} C_{ME} C_{NE}	6-D	Theory
168	0	0	250+250i	31415	3000	A1	A1	A1	Unstable	
169	0	0	250+250i	18850	3000	A1	A1	A1	-1.755 -2.154i	-1.957 -1.978i
170	0	0	250+250i	6283	3000	A1	A1	A1	-1.866 -2.054i	-1.936 -1.999i
171	0	0	250+250i	500	3000	A1	A1	A1	-1.572 -2.351i	-1.569 -2.366i
172	0	0	250+250i	300	3000	A1	A1	A1	-1.308 -2.595i	-1.304 -2.632i
173	0	0	250+250i	100	3000	A1	A1	A1	-0.114 -3.912i	-0.024 -3.959i
174	0	0	250+250i	50	3000	A1	A1	A1	1.873-6.399i	1.441-6.134i
175	0	0	250+250i	25	3000	A1	A1	A1	3.755-10.393i	3.751-10.486i
176	0	0	250+250i	10	3000	A1	A1	A1	7.435-34.530i	7.247-34.867i
177	0	0	250+250i	5	3000	A1	A1	A1	-11.870 -44.054i	-12.144 -44.243i
178	0	0	250+250i	0	3000	A1	A1	A1	-35.054 -35.053i	-35.164 -35.164i

TABLE XVIII

THEORY VALIDATION, ASYMMETRIES, CASES 179-189

CASE	Initial Conditions					Coefficients			J.A. (mils)	
	$\vec{S}_o$	$\vec{\alpha}_o$	$\vec{\dot{\alpha}}_o$	p_o	u_o	C_{Z_α} C_{M_α} $C_{M_q}+C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$ $C_{M_{p\beta}}$	C_{YE} C_{ZE} C_{ME} C_{NE}	6-D	Theory
179	0	0	250+250i	31416	1000	A1	A1	A1	Unstable	
180	0	0	250+250i	18850	1000	A1	A1	A1	Unstable	
181	0	0	250+250i	6283	1000	A1	A1	A1	Unstable	
182	0	0	250+250i	500	1000	A1	A1	A1	-5.015 -5.503i	-5.302 -5.769i
183	0	0	250+250i	300	1000	A1	A1	A1	-4.884 -5.572i	-5.144 -5.925i
184	0	0	250+250i	100	1000	A1	A1	A1	-4.208 -6.135i	-4.366 -6.705i
185	0	0	250+250i	50	1000	A1	A1	A1	-3.056 -7.031i	-3.191 -7.892i
186	0	0	250+250i	25	1000	A1	A1	A1	-0.741 -9.079i	-0.841 -10.242i
187	0	0	250+250i	10	1000	A1	A1	A1	5.244-18.344i	4.637-20.016i
188	0	0	250+250i	5	1000	A1	A1	A1	18.563-33.158i	18.976-36.752i
189	0	0	250+250i	0	1000	A1	A1	A1	-61.894 -61.894i	-63.990 -63.990i

Figures 22, 23 and 24 illustrate Cases 157-189. The curves are similar to those in Figures 7, 8 and 9 but are displaced by the $\dot{\vec{\alpha}}_o$ contribution. Cases 168, 179, 180 and 181 indicate that maximum effects of the various parameters has been achieved in other stable cases. The effects of roll rate and velocity follow the same trends as those in Cases 58-90. Figure 25 shows the effects of velocity for Cases 157-189. Cases with U = 3000 ft/sec exhibit the smallest dispersion. A sample trajectory, Case 189, is shown in Figure 26.

Comparison: High, Low, Very Slow Roll Rate Theories

In Cases 58-189 the High, Low, and Very Slow Roll Rate Theories are validated for various initial conditions and parameters. The theories have been applied for certain ranges in roll rate and roll rate times time (pt.) The range of pt, ($pt \leq 1.0$) are governed by the inherent requirements of power series expansion. However, the ranges of p are arbitrary (to a certain extent) and are based on accuracy of the theories themselves. Each theory approximates the solution very well for a certain range of p and then begins to diverge and become inaccurate. The range of p for which the very slow roll rate theory is accurate is fairly well cut and dried; $p \geq 0$, $pt \leq 1.0$. For any $pt > 1.0$ we must now use the low roll rate theory. The question now arises, how high a roll rate can this theory accommodate? At what value of p must we change to the high roll rate theory? These questions are answered by a plot of sample 6-D computations, Figure 27

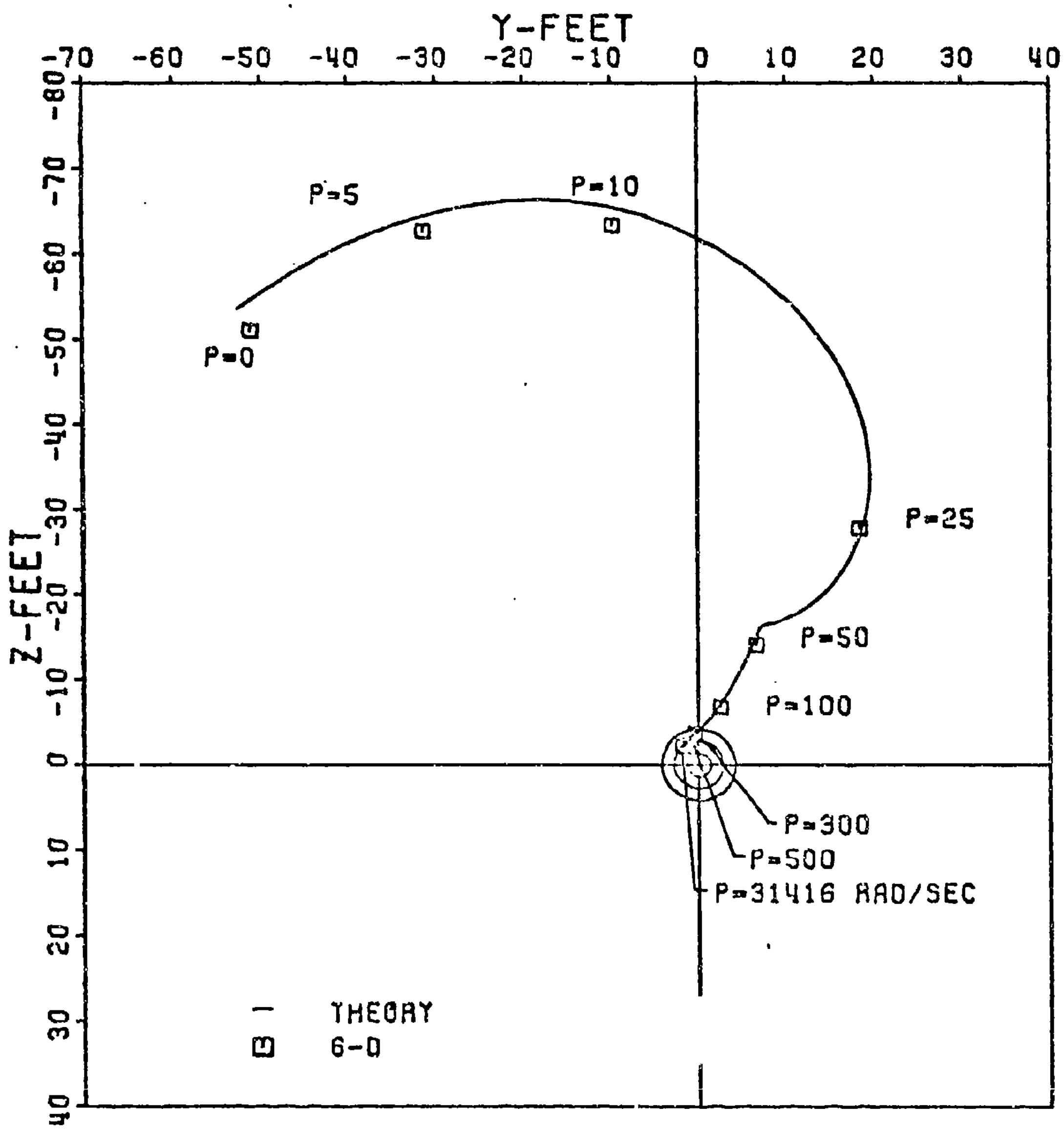


Figure 22. Dispersion: Phase III Cases 157-167

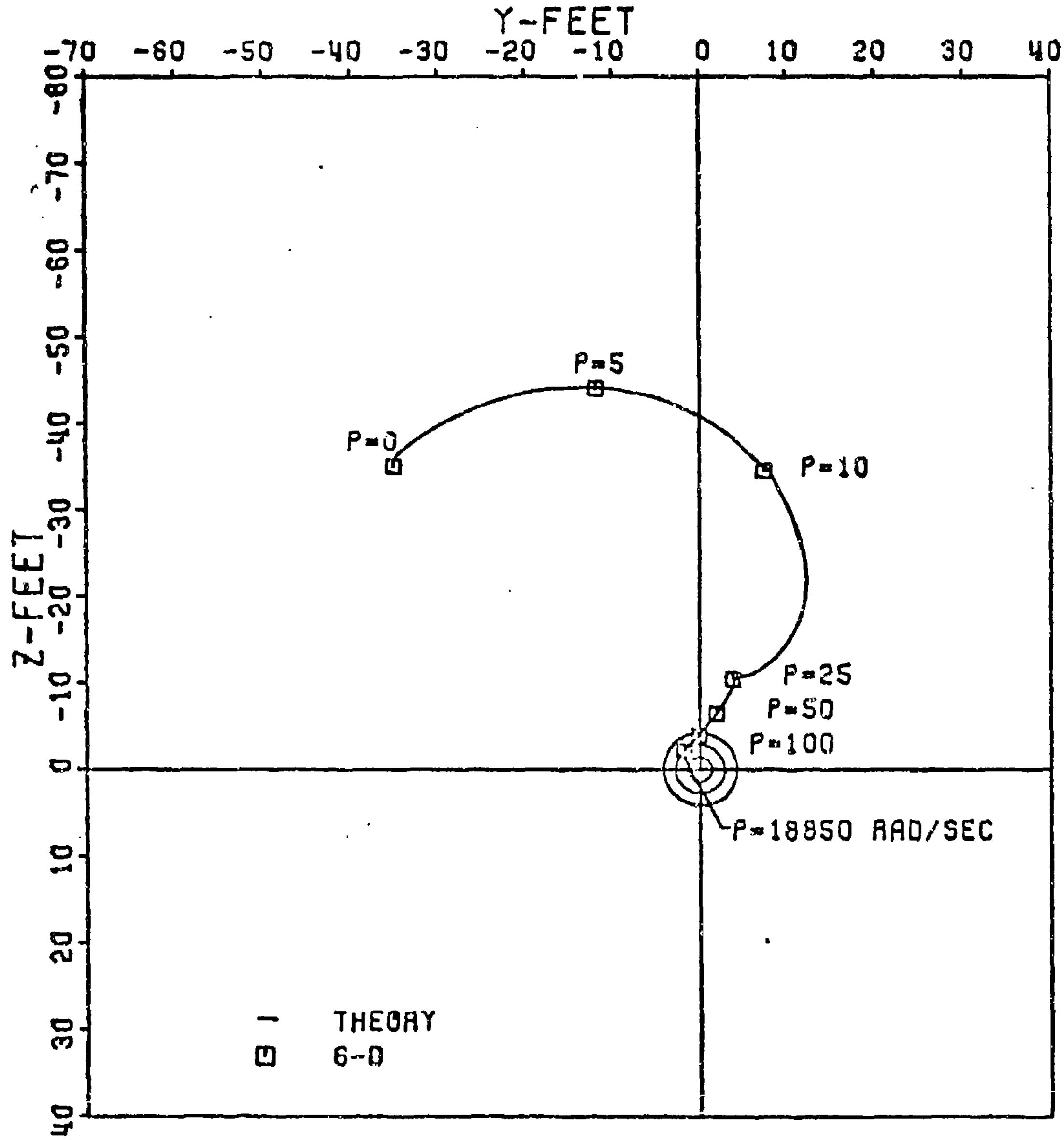


Figure 23. Dispersion: Phase III Cases 168-178

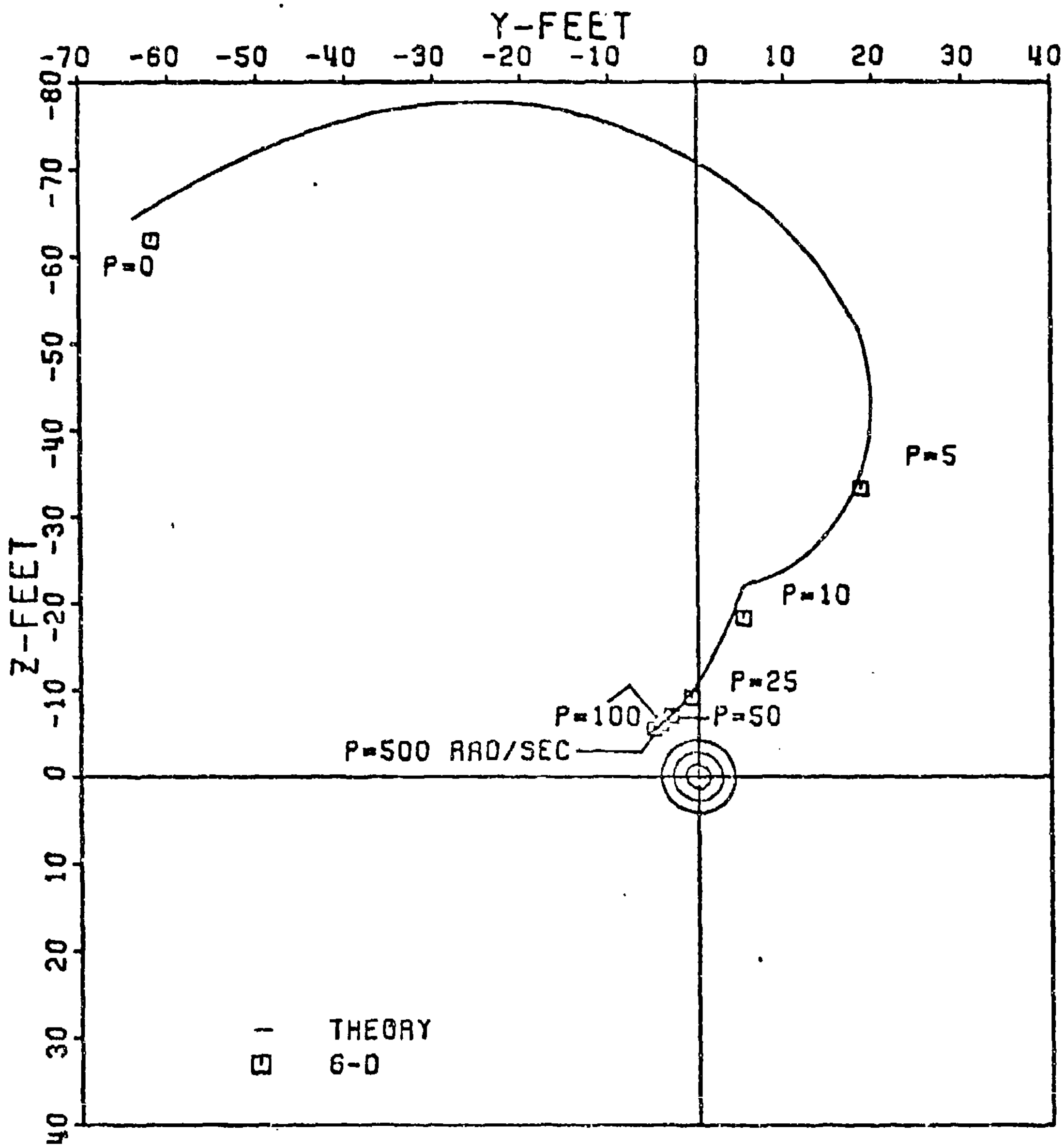


Figure 24. Dispersion: Phase II Cases 179-189

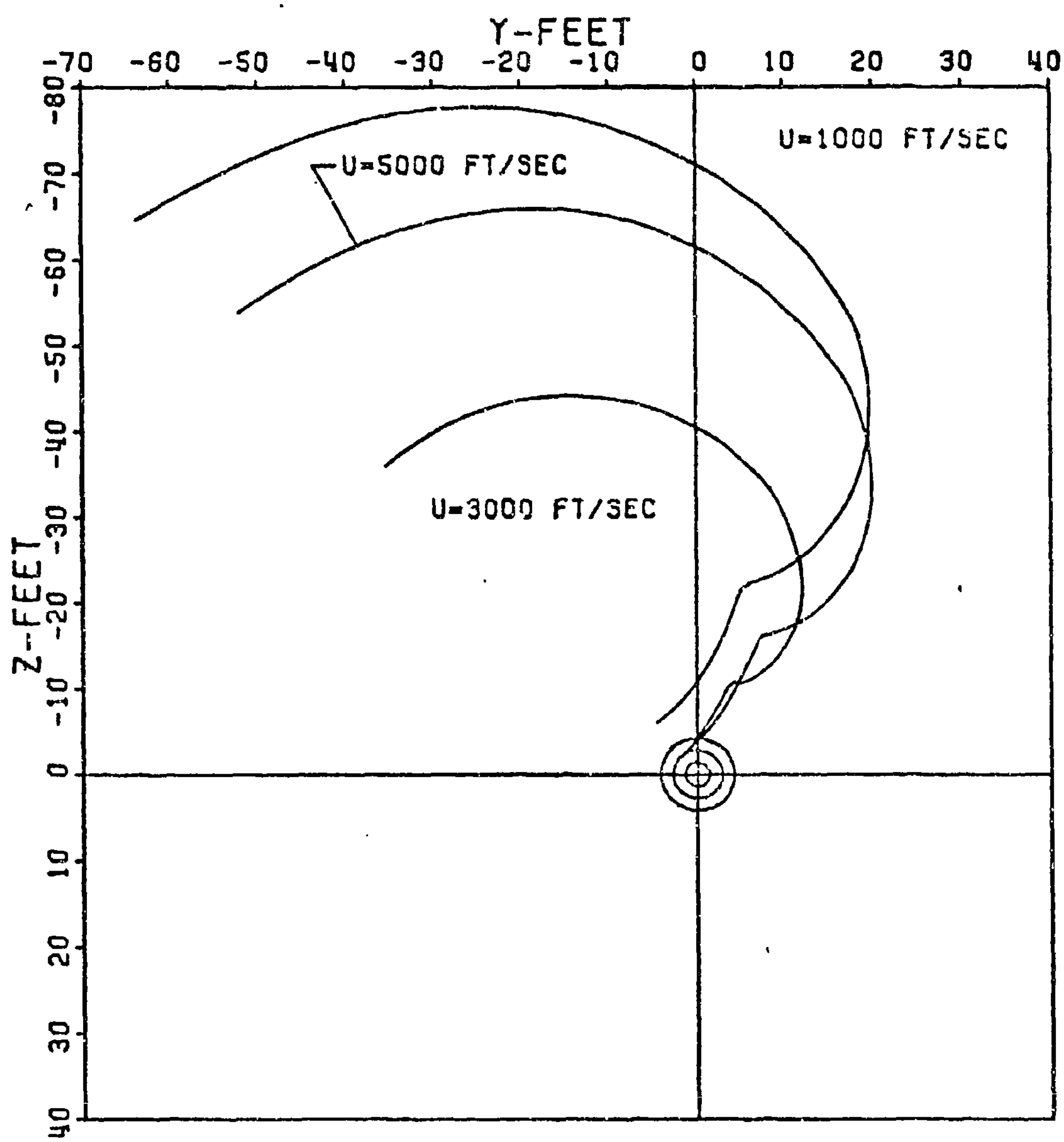


Figure 25. Dispersion: Phase III Theory, Cases 157-189

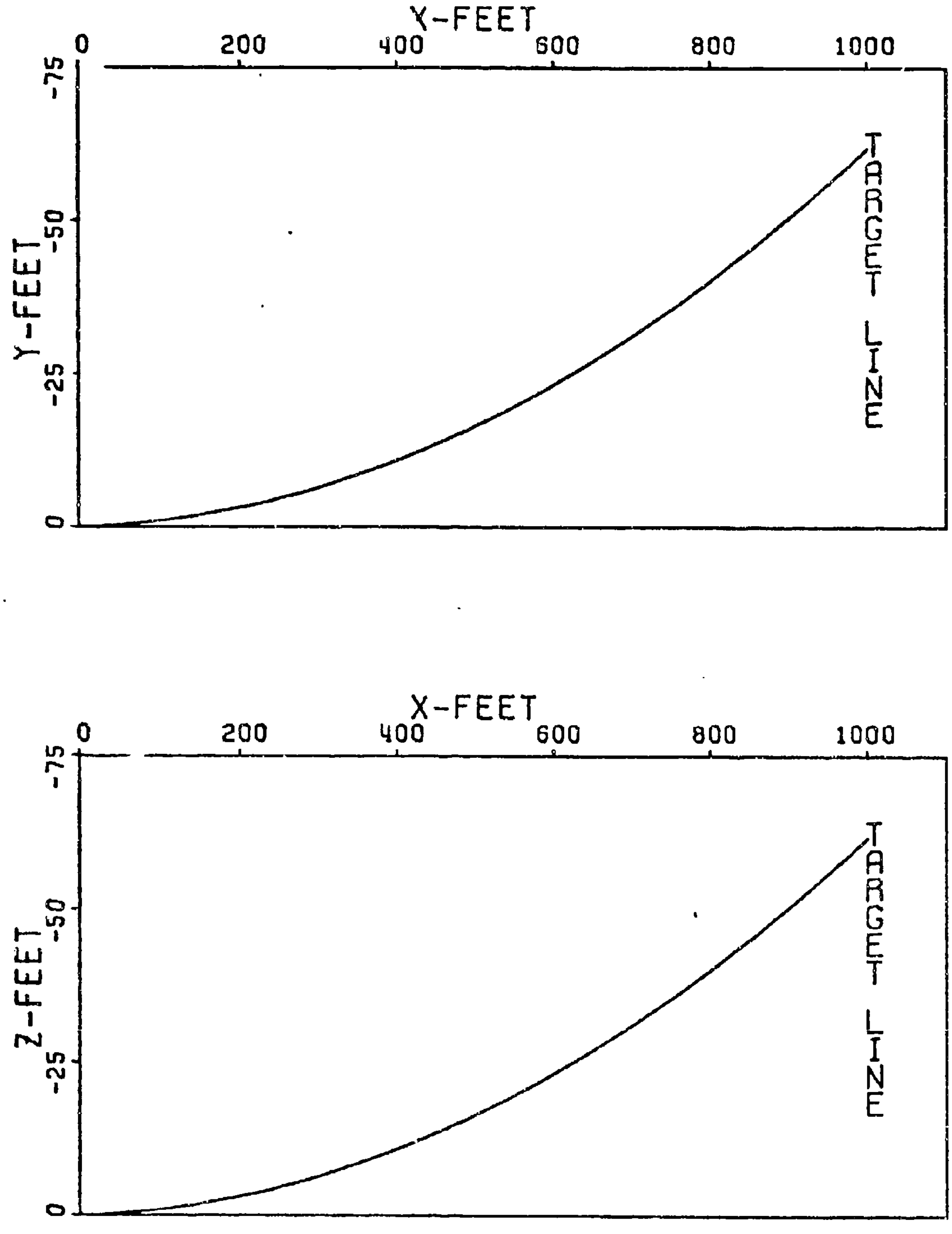


Figure 26. Trajectory, Case 189

and all three theories extended beyond the limits used in the previous validation. The high roll rate theory is a straight line going off to infinity as p goes to zero. Although the length of the curve in which it is an effective theory is short graphically, the range of roll rates it encompasses is tremendous. Figure 28 illustrates the effective limits of each theory; that is, on the spectrum of possible roll rates it shows where each theory is the most effective. The low roll rate theory handles the largest graphical area but only roll rates less than 100 rad/sec and greater than 5 rad/sec. The upper limit of 100 rad/sec was chosen since here the low roll theory attaches itself to the 6-D results while the high roll theory diverges. The lower limit of 5 rad/sec corresponds to $pt \leq 1.0$. Figures 27 and 28 depict Cases 58-68 where u_o = 5000 ft/sec or t = 0.2 sec. Therefore p = 5 rad/sec corresponds to pt=1.0. The very low roll rate theory has the smallest range but is essential in predicting dispersion as the roll rate goes to zero. As $pt > 1$, the theory diverges as would be expected from a power series; Equation 29. The sharp turn occurs at $p \approx 20$ rad/sec or $pt \approx 4$ for Cases 58-68. Although Cases 58-68 were illustrated here, this analysis of the effective limits of the roll theories was found to be similar for all other cases. For the u_o = 3000 ft/sec cases the low roll theory limits were $3.0 < p < 50$ for u_o = 1000 ft/sec cases: $1.0 < p < 25.0$.

Phase IV

To validate the effects of gravity on dispersion, a final set of cases were run using the high roll rate theory, Equation 24. Ordinarly, one would think that gravity would only introduce a constant term; one

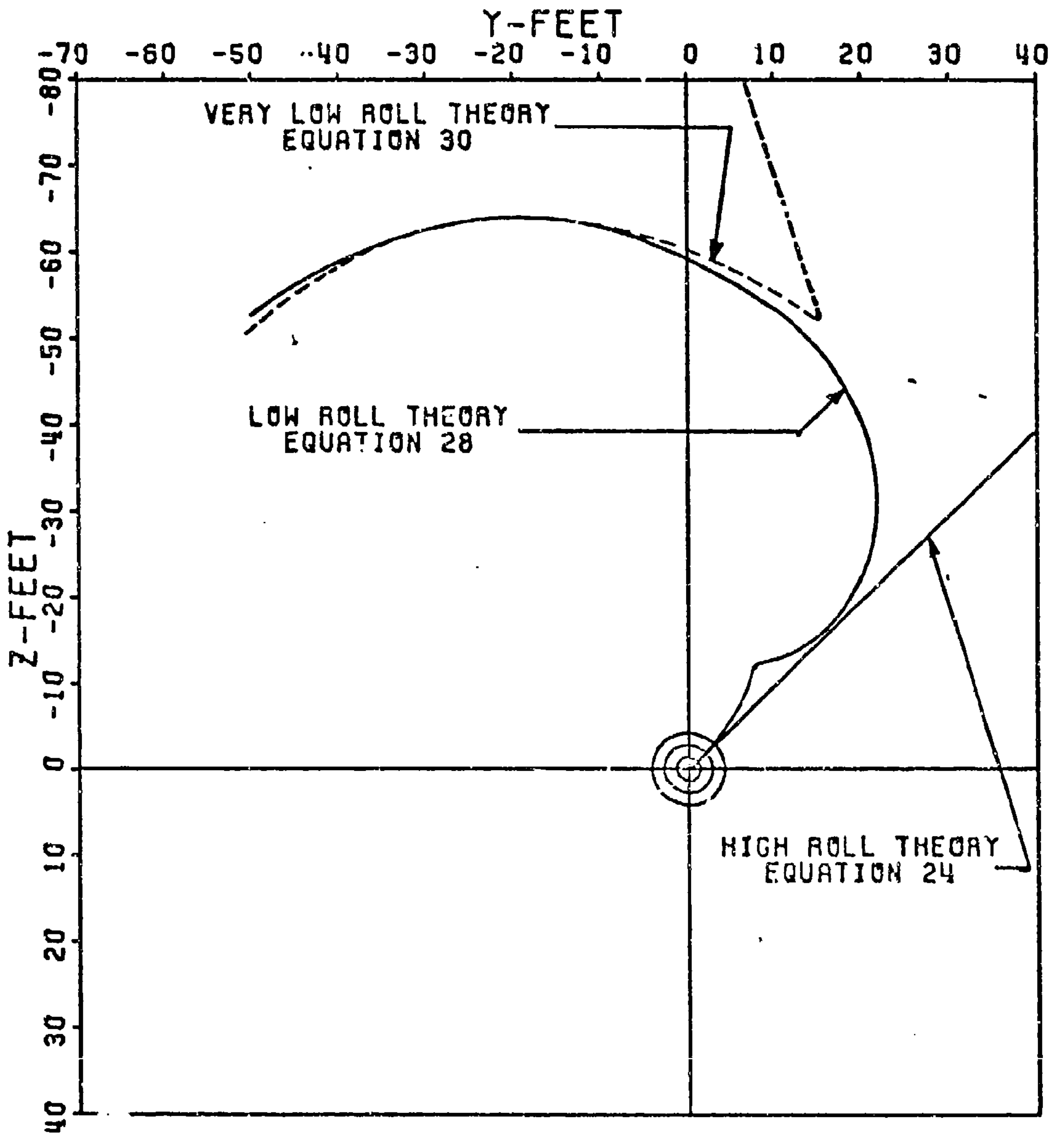


Figure 27. Phase III Theory Equations 24, 28, 30

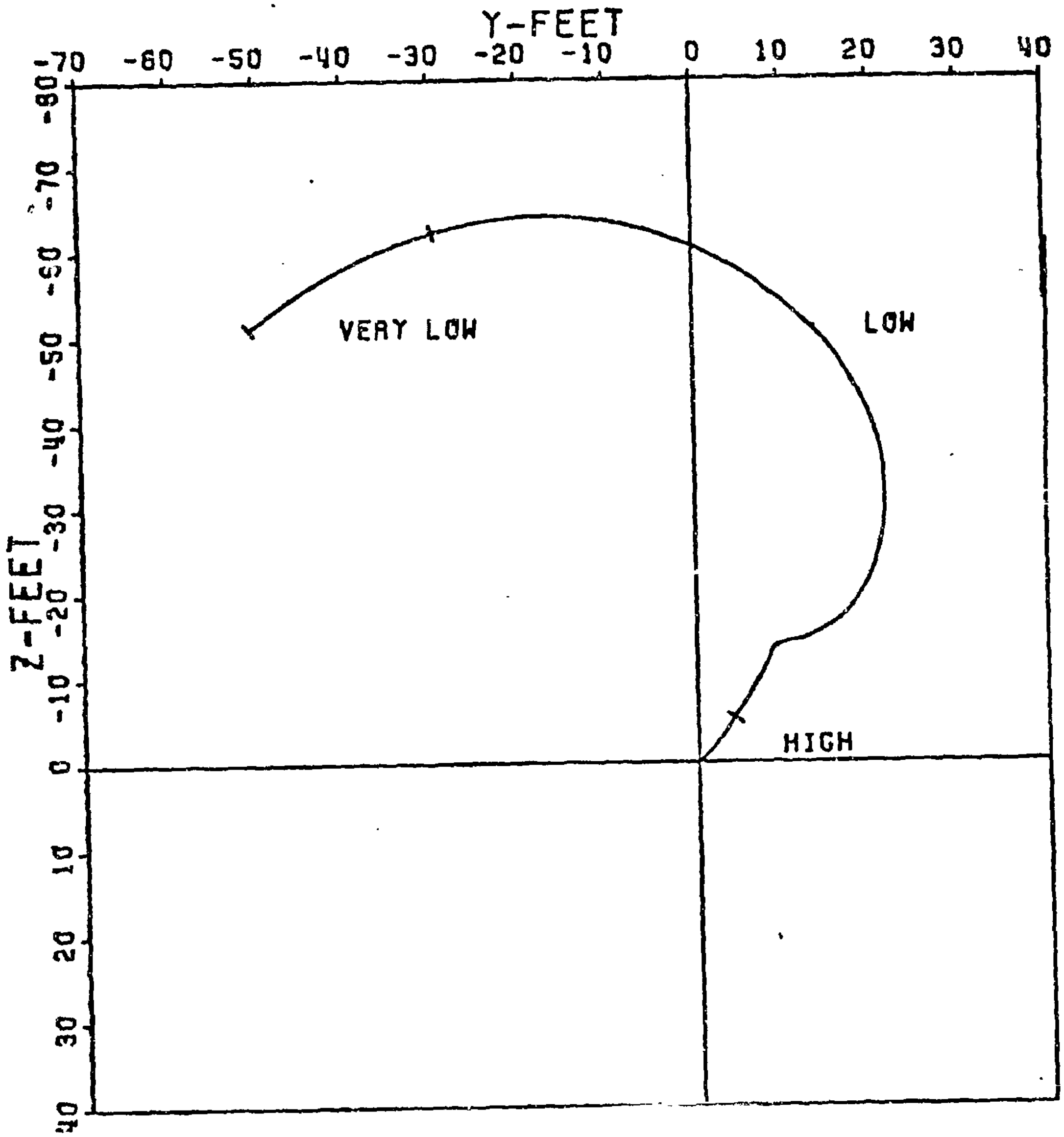


Figure 28. Phase III Theory Effective Limits

that could be factored out. However integration of the equations of motion produce a gravity term dependent upon roll rate. Determination of its validity and consequence is what is important here. $\vec{\dot{S}}_o$, $\vec{\alpha}_o$, and $\vec{\dot{\alpha}}_o$ were set to zero in order to allow determination of the effects due to roll rate and velocity. The reduced governing equation becomes:

$$\overrightarrow{J.A.} = \frac{ig}{2}\left(\frac{x}{u^2}\right)\left[1 + \frac{ipI_x}{mud} A\right] 1000$$

No aerodynamic asymmetrics were present and the effects of gravity were assumed independent of effects due to $\vec{\dot{S}}_o$, $\vec{\alpha}_o$, $\vec{\dot{\alpha}}_o$; a logical assumption. Table XIX lists the results.

Table XIX indicates that the effects due to gravity occur largely in the vertical plane, as would be expected. The transverse contribution is minimal but is affected by both velocity and roll rate. The vertical contribution is only affected by velocity. The unstable cases indicate maximum use of Magnus and thus maximum transverse effects on dispersion. It can be concluded from this brief but thorough treatment that gravity effects dispersion only in the vertical plane (for all practical purposes) and that its contribution is constant with velocity. The roll dependent term, $\frac{ipI_x}{mud} A$, has been shown to exist but become negligible for the flechette. This term would possibly become important for projectile dispersion and other missile applications. Projectile motion with gravity is typified by a cocking right of the projectile in flight with a positive C_{M_α} but negative C_{Z_α}; the parameter A would become negative and the entire roll dependent term, positive; that is, cocked to the right, dispersion to

TABLE XIX

THEORY VALIDATION,GRAVITY
CASES 190-201

CASE	Initial Conditions					Coefficients			$\overrightarrow{J.A.}$ (mils)	
	$\vec{\dot{S}}_o$	$\vec{\alpha}_o$	$\vec{\dot{\alpha}}_o$	p_o	u_o	C_{Z_α} C_{M_α} $C_{M_q}+C_{M_{\dot{\alpha}}}$	$C_{Z_{p\beta}}$ $C_{M_{p\beta}}$	C_{YE} C_{ZE} C_{ME} C_{NE}	6-D	Theory
190				31416					-0.001 +0.644i	-0.001 +0.644i
191				18850	5000				-0.001 +0.644i	-0.001 +0.644i
192				6283					-0.001 +0.644i	-0.001 +0.644i
193				0					0.000 +0.644i	0.000 +0.644i
194				31416					-0.002 +1.788i	-0.003 +1.789i
195	0	0	0	18850	3000	A1	A1	0	-0.001 +1.789i	-0.002 +1.789i
196				6283					0.000 +1.788i	-0.001 +1.789i
197				0					0.000 +1.788i	0.000 +1.789i
198				31416					Unstable	
199				18850	1000				Unstable	
200				6283					0.001+ 16.100i	0.001+ 16.100i
201				0					0.000+ 16.100i	0.000+ 16.100i

the right. For a finned missile the opposite would occur due to the agreement in sign between C_{M_α} and C_{z_α}.

FREE FLIGHT DATA ANALYSIS

In order to analyze actual test firings as to jump and dispersion and correlate them with the validated theory, the initial conditions of each test firing must be obtained and put into the proper form. To obtain raw experimental data, test firings were conducted by the U.S. Army, Frankford Arsenal. The configuration tested was the Producibility Ground Point Flechette, Figure 29. The raw data required was both translational and angular; that is, data was needed to determine position as a function of time and angle of attack of the flechette as a function of time. To accomplish this, Frankford Arsenal devised the test apparatus shown in Figure 30. The gun barrel was mounted on a steel girder and a laser beam was used to obtain the aim point on a target 50 meters down range. At positions, 1, 3, 5, 7, 9, and 11 feet downrange, orthogonal flash x-ray tubes were placed to photograph the flechette as it passed its station. One tube was placed to allow a top view at each station and provide a means of obtaining swerve and yaw data. The other tube allowed a side view at each station to obtain heave and pitch data. At each station reference marks oriented the flechette as to its exact position downrange. This was to allow for any timing error and/or variation in muzzle velocity. The photographs were taken using special soft flash x-ray tubes which permit the photographing of the low density sabot pieces and analyzing the separation in addition to the motion of the flechette.

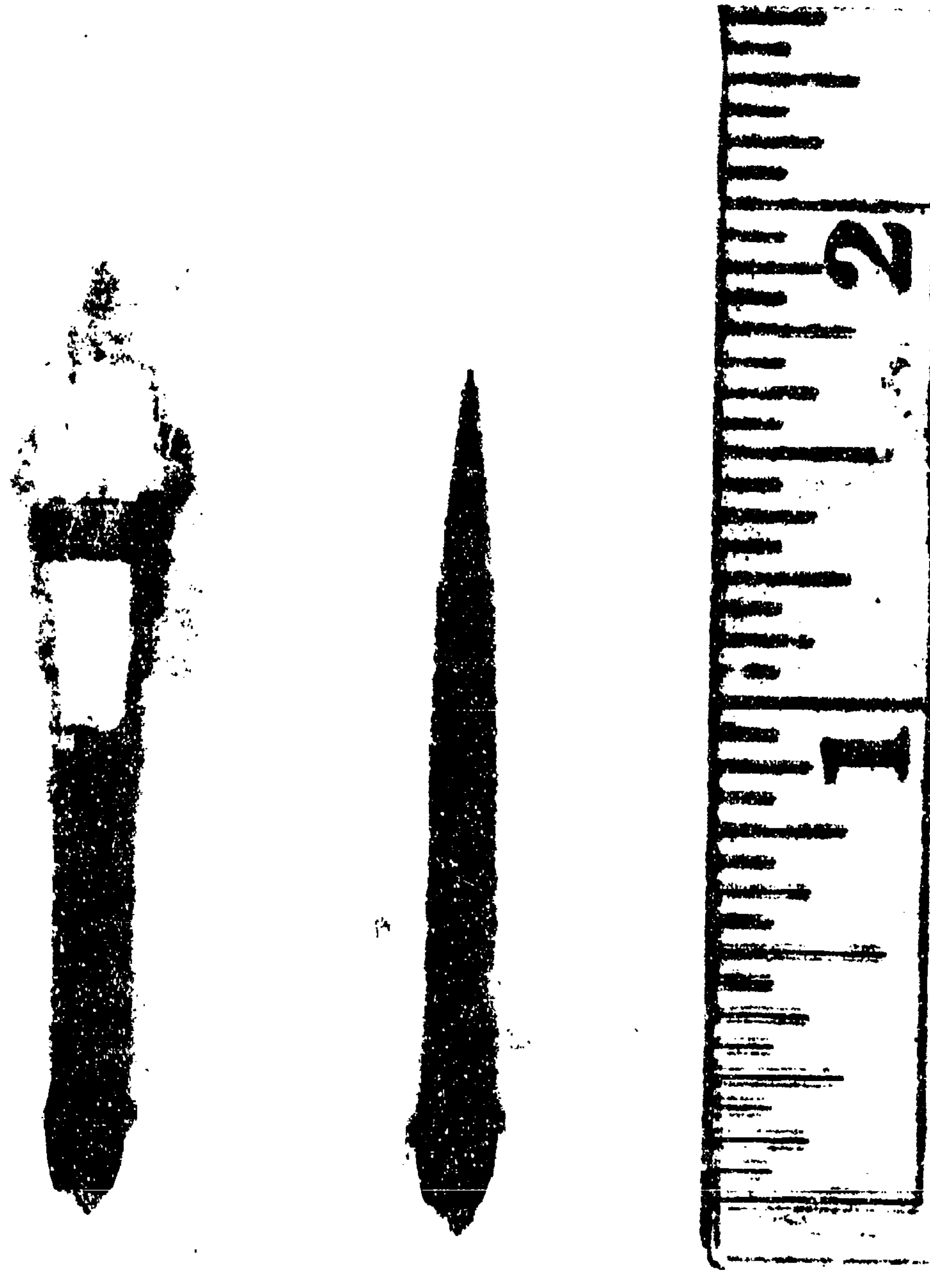


Figure 29. Ground Point Flechette, With and Without Sabot

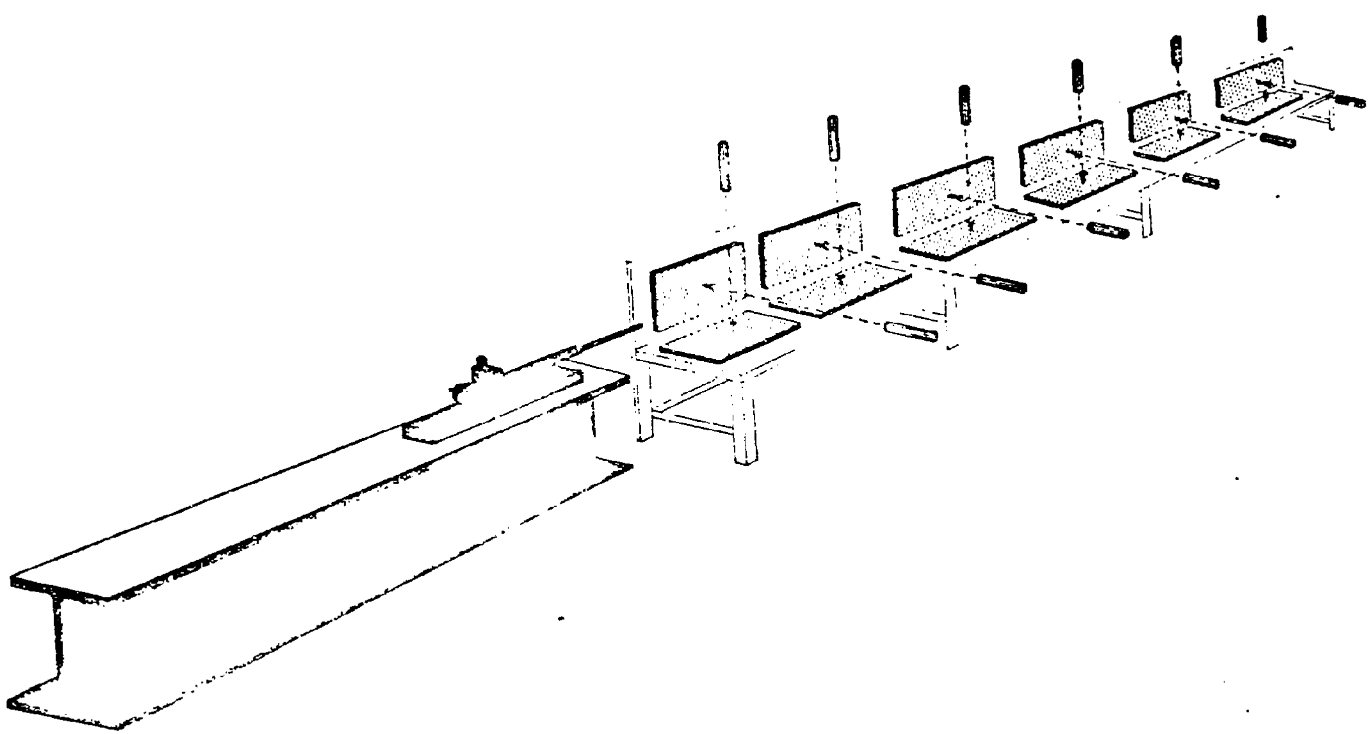


Figure 30. Free Flight Test Apparatus and Set-up

From the battery of test firings of 20 rounds of each type (which included tests of the ground point, and swayed point producibility flechette as well as the R&D version), 8 of the ground point producibility rounds were selected to be analyzed. The eight rounds along with velocity, roll rates and target positions are given in Table XX.

Raw translational and angular data are shown in Figures 31 through 46. The figures illustrate the position and complex angle of attack of the flechette for each station.

TABLE XX

FRANKFORD TEST FIRING DATA

ROUND	u_o	p_o	Target at 50 ft.	
			Y (ft)	iZ (ft)
4	4747	11,454	0.117	-0.038
6	4662	13,201	0.053	-0.010
7	4642	14,219	0.141	-0.004
8	4662	13,000	0.053	0.099
14	4758	13,289	0.053	0.016
16	4753	17,354	0.084	-0.004
17	4677	16,613	0.070	-0.019
19	4679	11,913	0.089	0.059

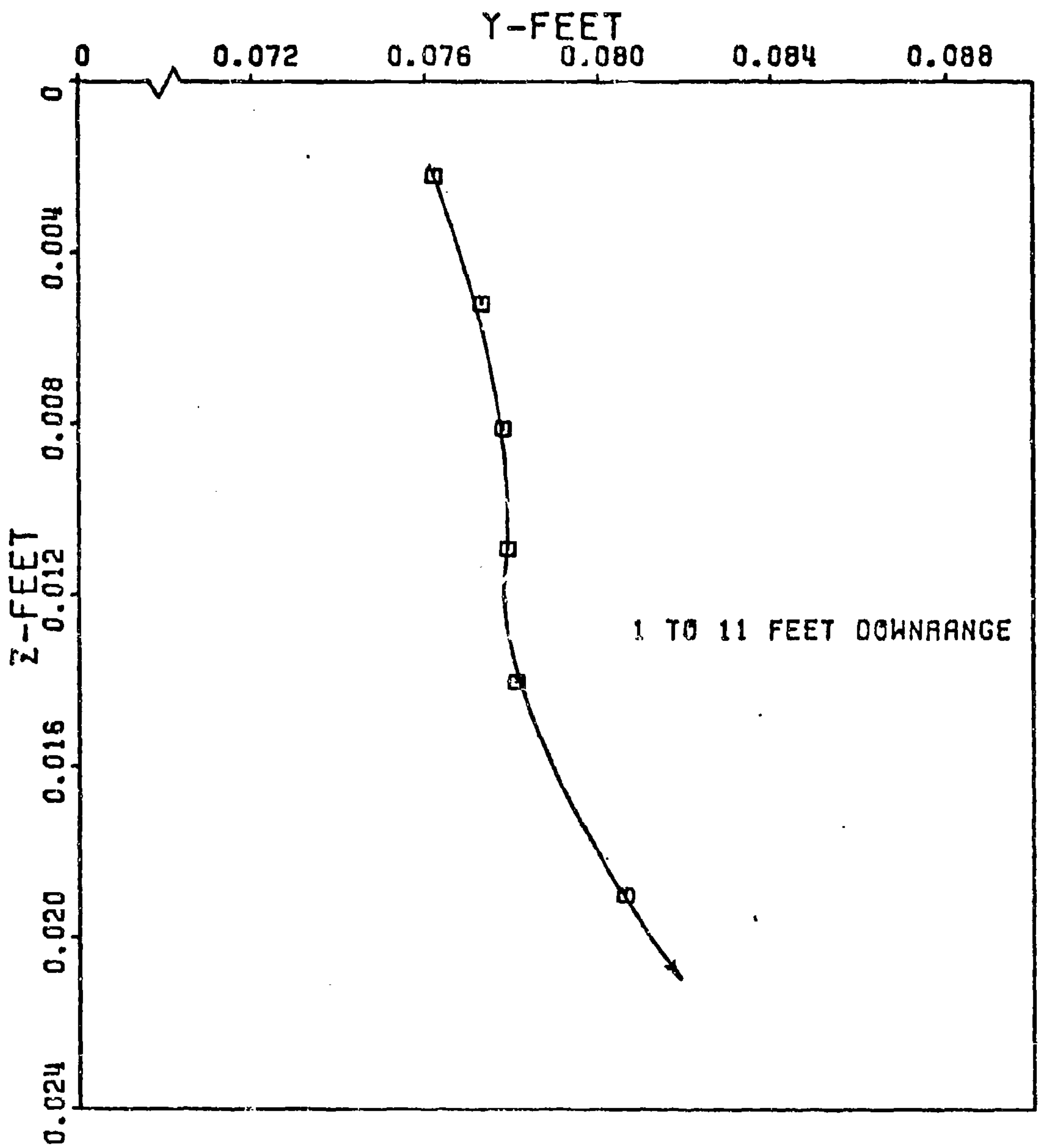


Figure 31. Raw Translational Data Ground Point - Round 4

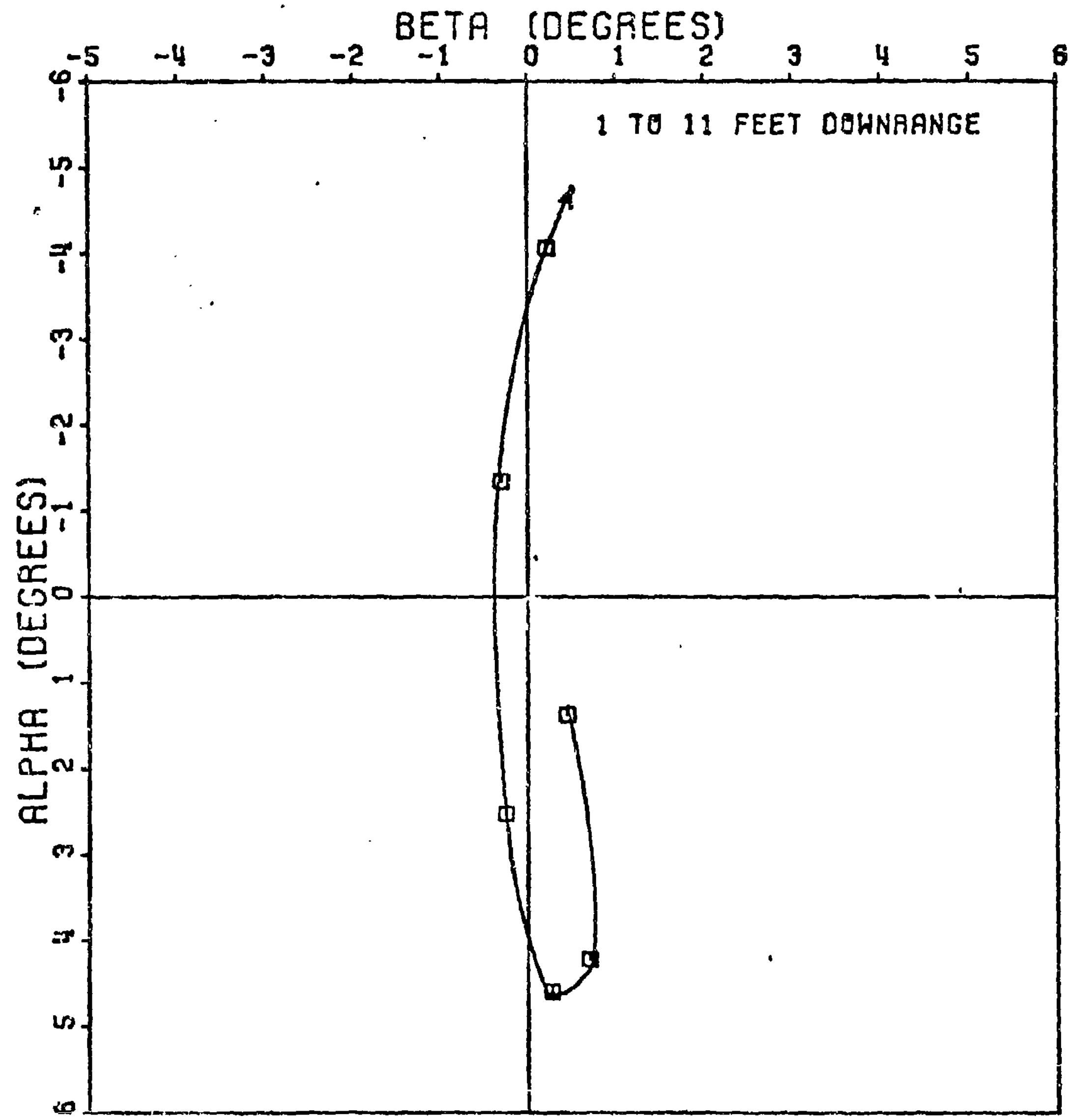


Figure 32. Raw Angular Data Ground Point - Round 4

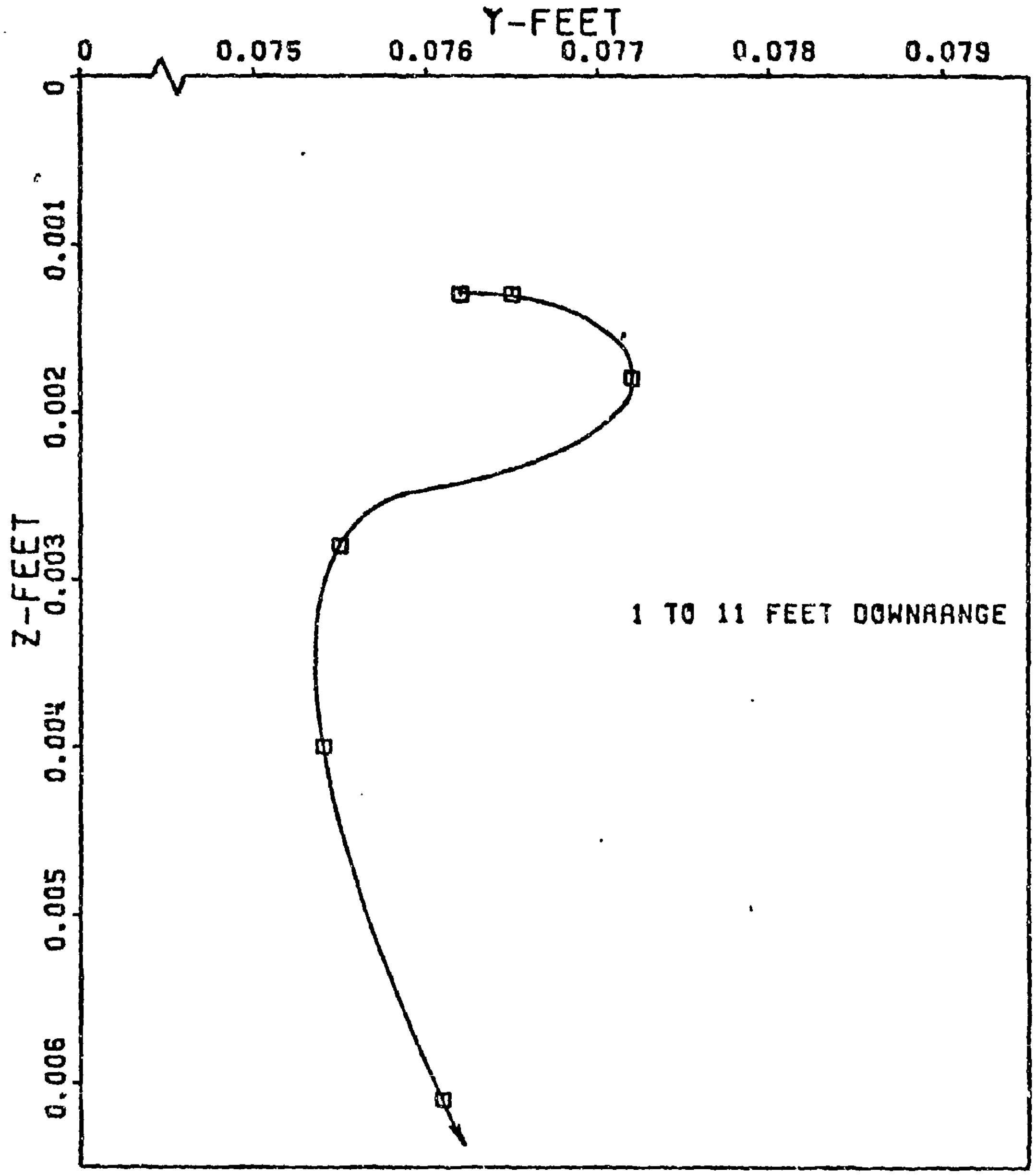


Figure 33. Raw Translational Data Ground Point - Round 6

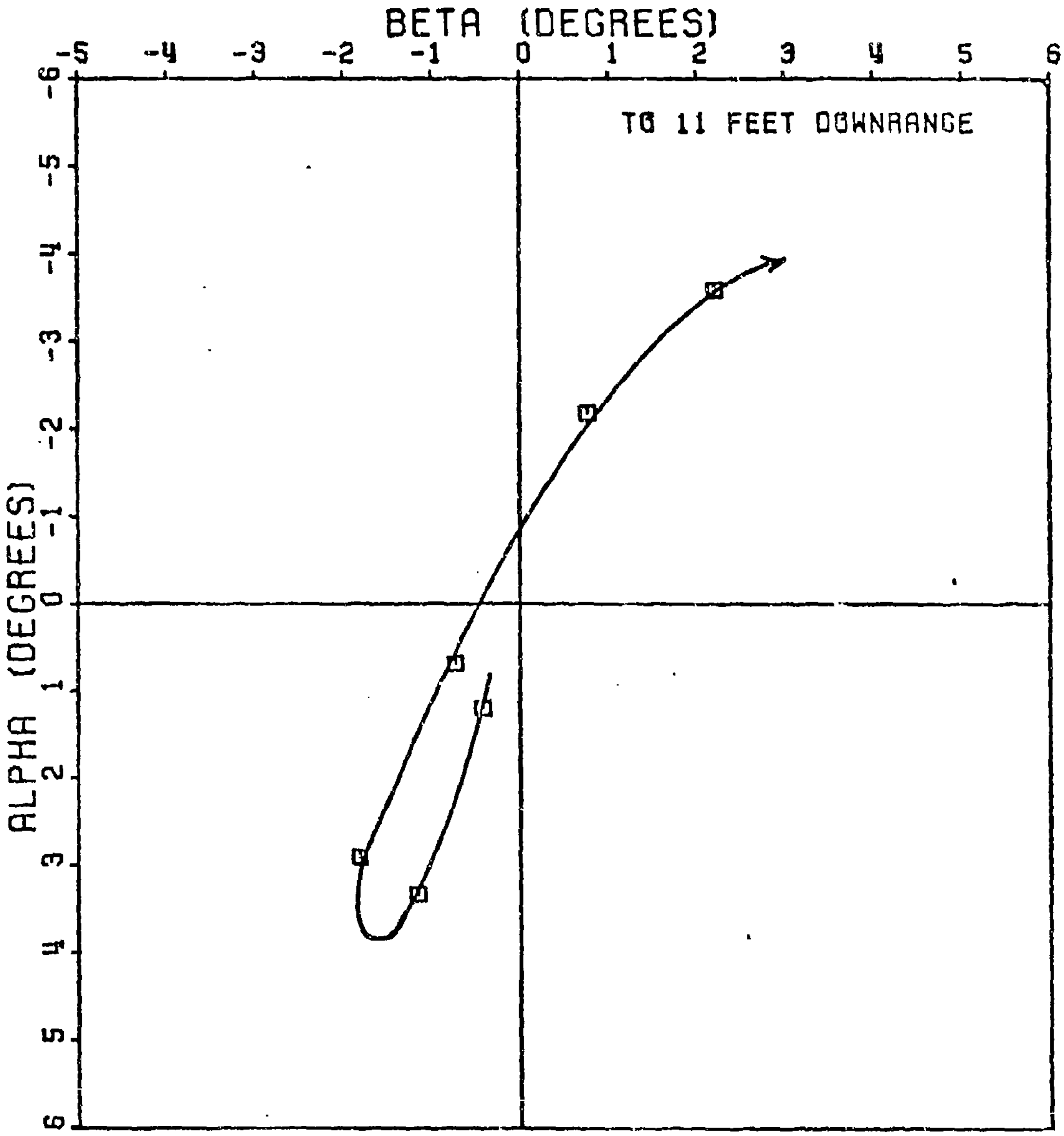


Figure 34. Raw Angular Data Ground Point - Round 6

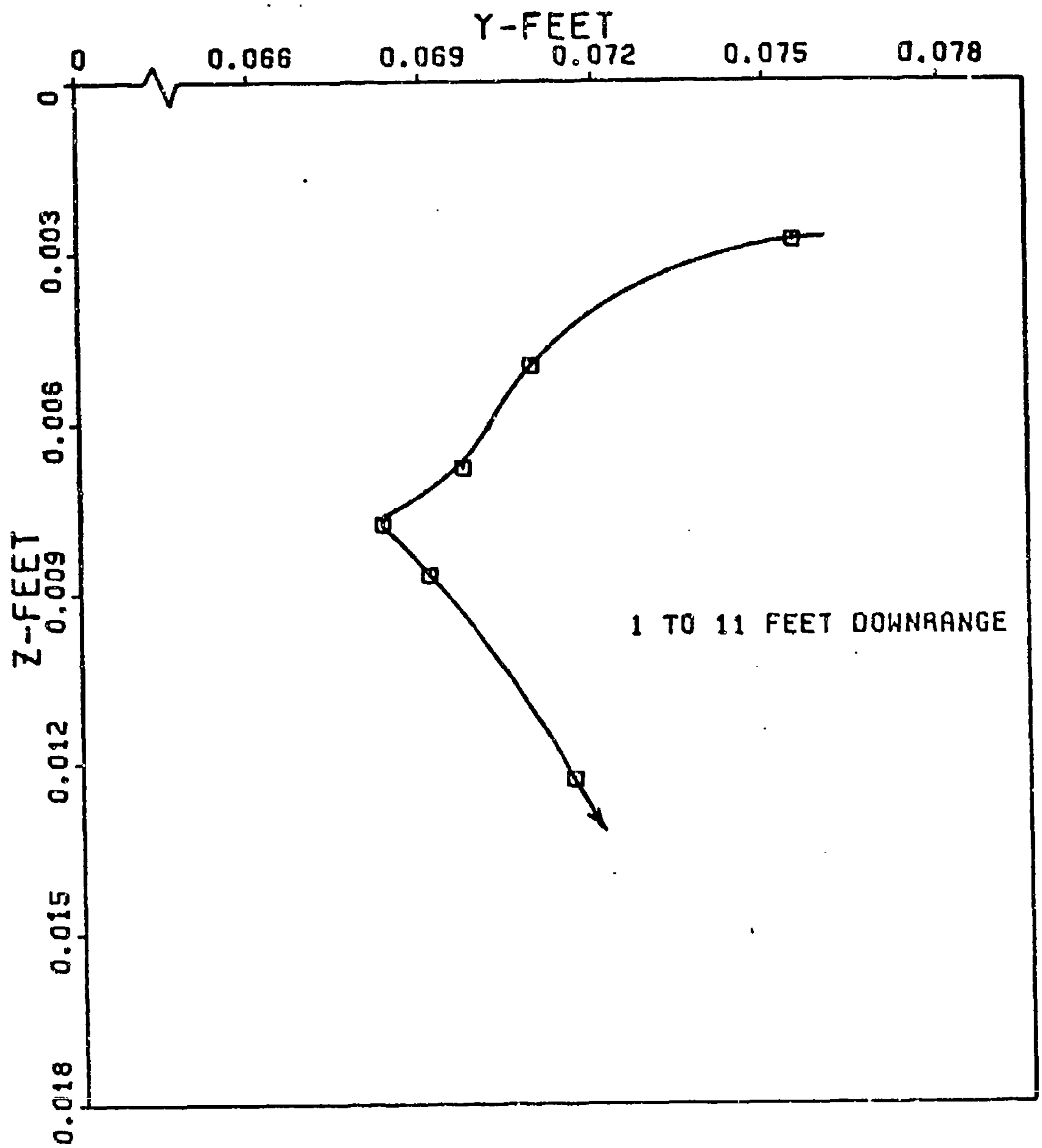


Figure 35. Raw Translational Data Ground Point - Round 7

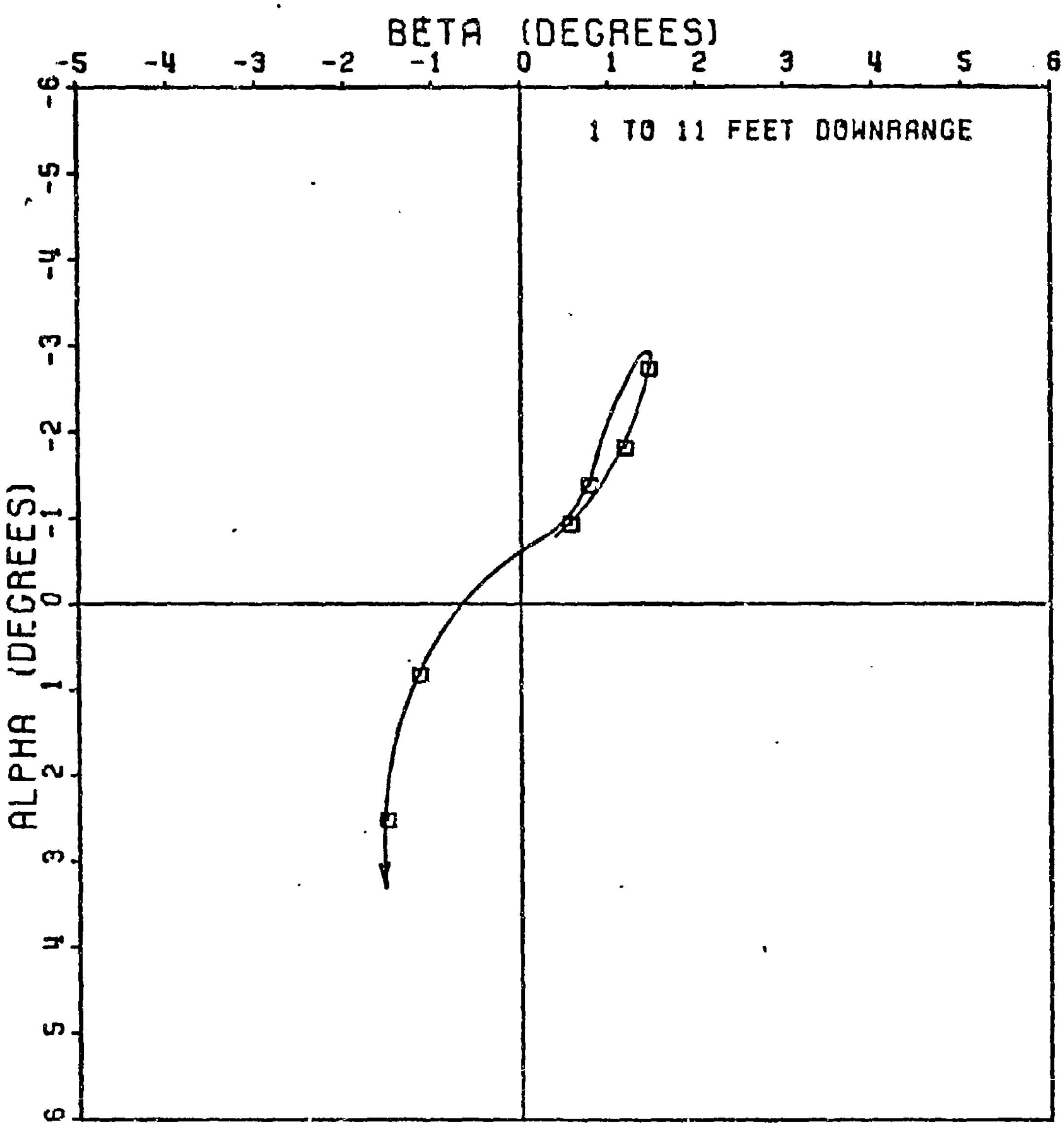


Figure 36. Raw Angular Data Ground Point - Round 7

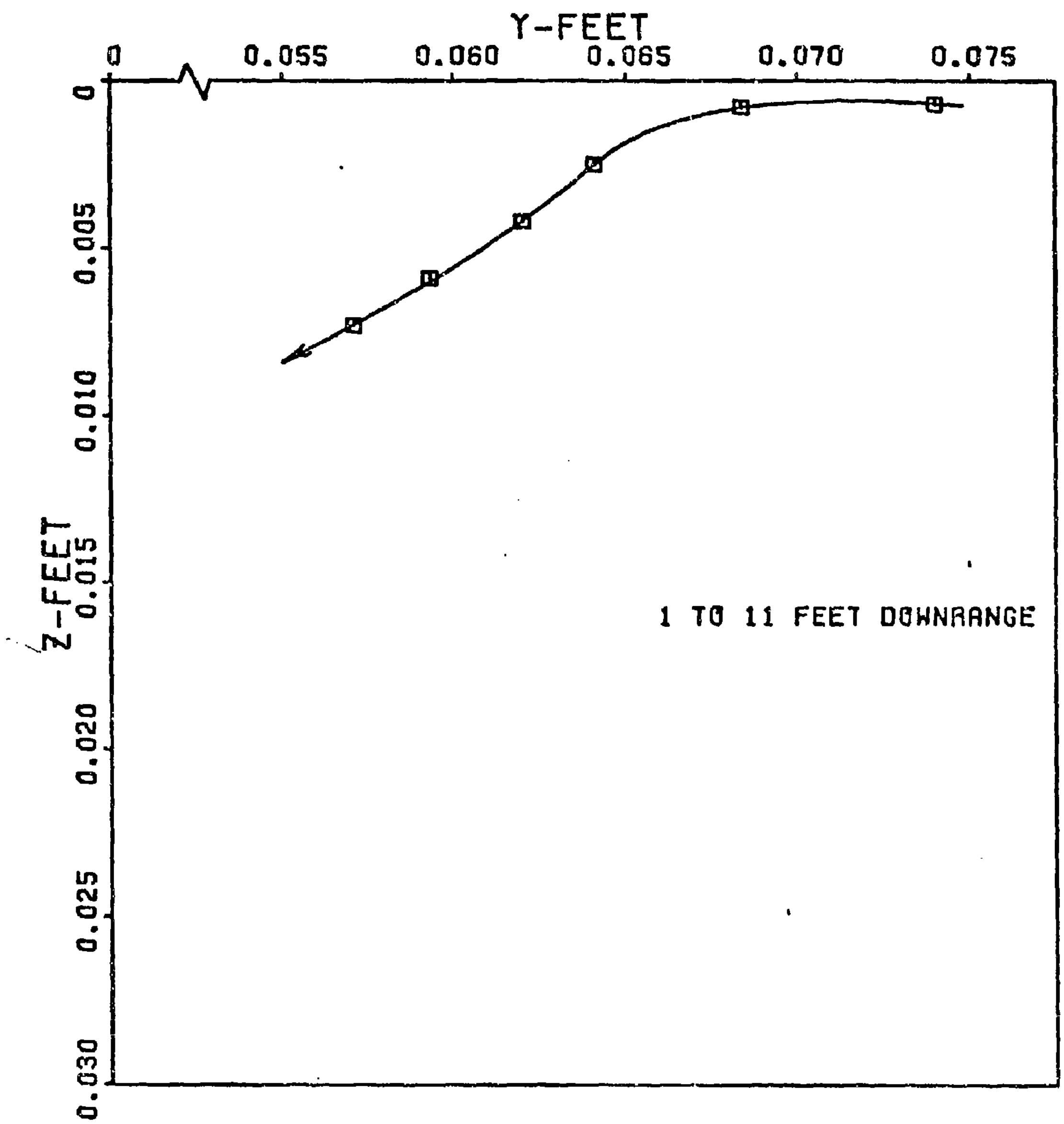


Figure 37. Raw Transl tional Data Ground Point - Round 8

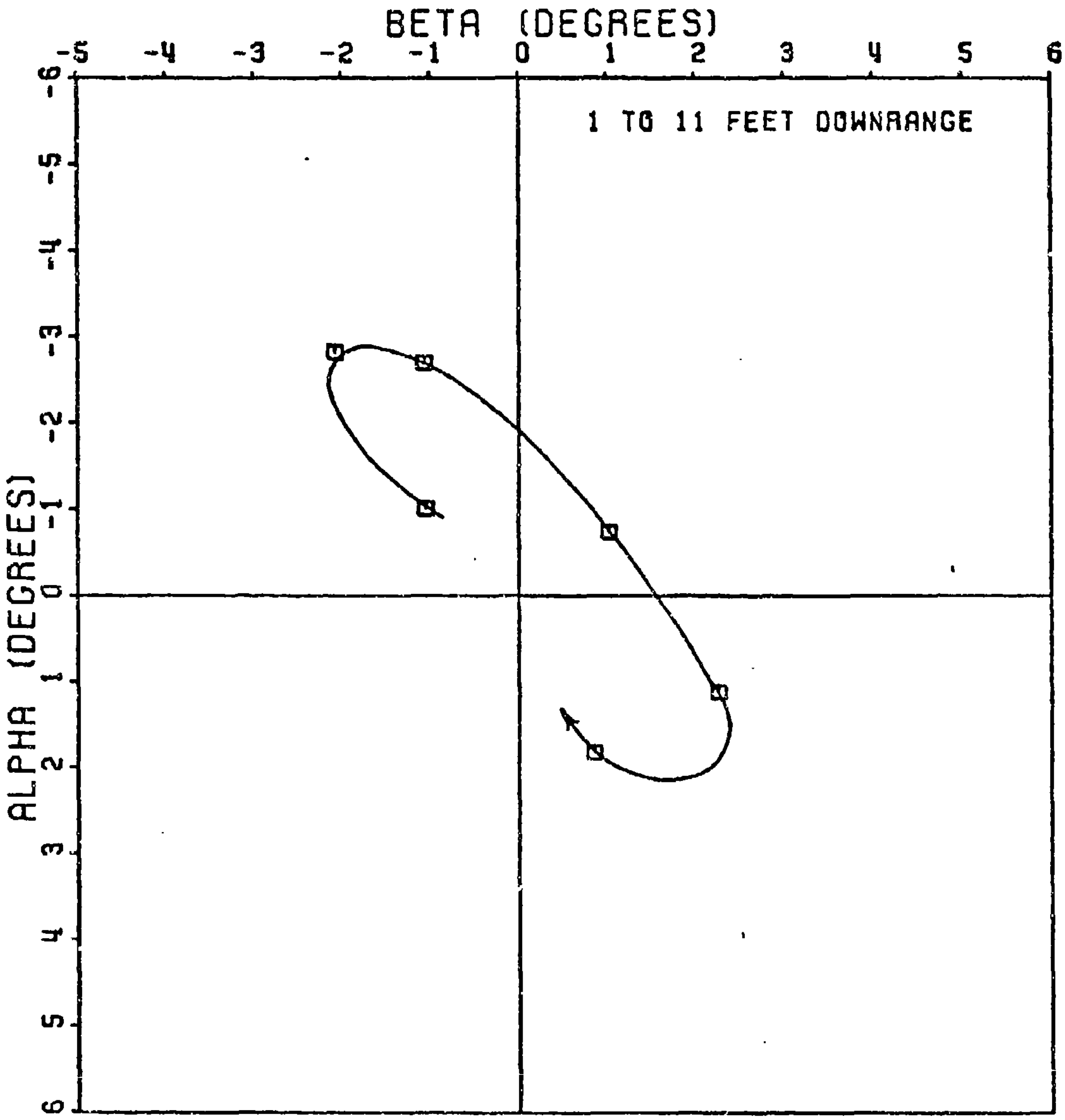


Figure 38. Raw Angular Data Ground Point - Round 8

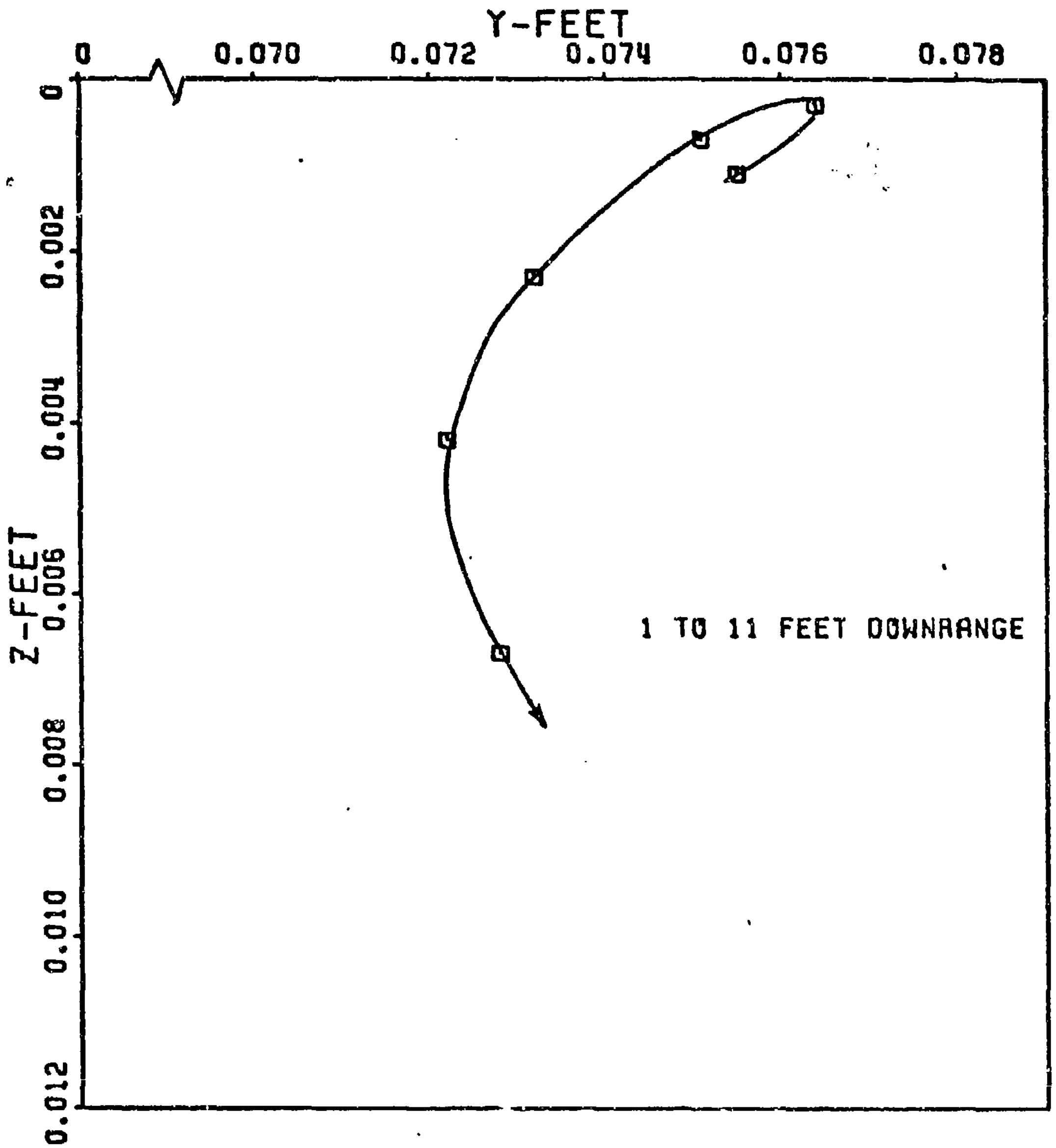


Figure 39. Raw Tranlational Data Ground Point - Round 14

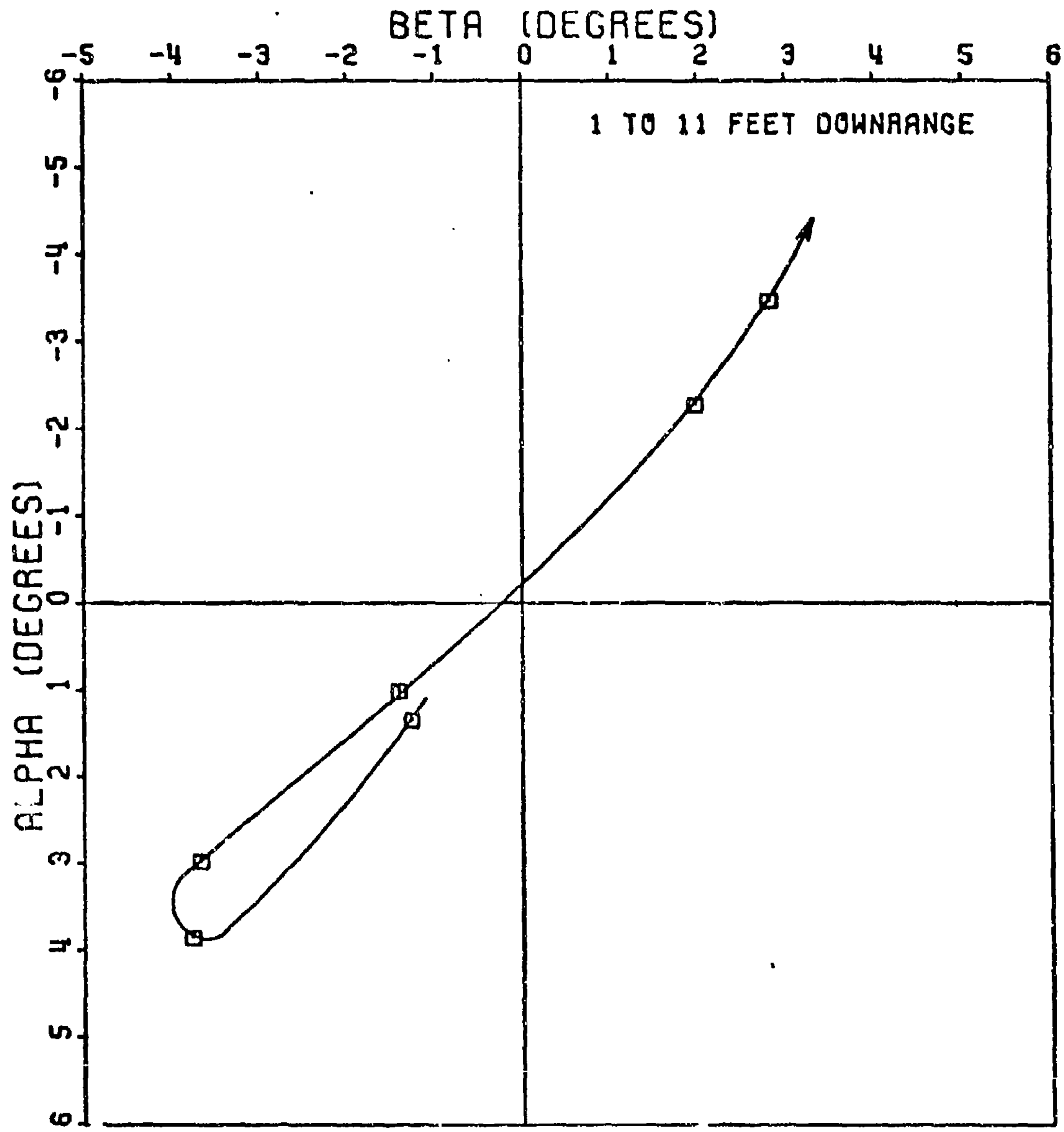


Figure 40. Raw Angular Data Ground Point - Round 14

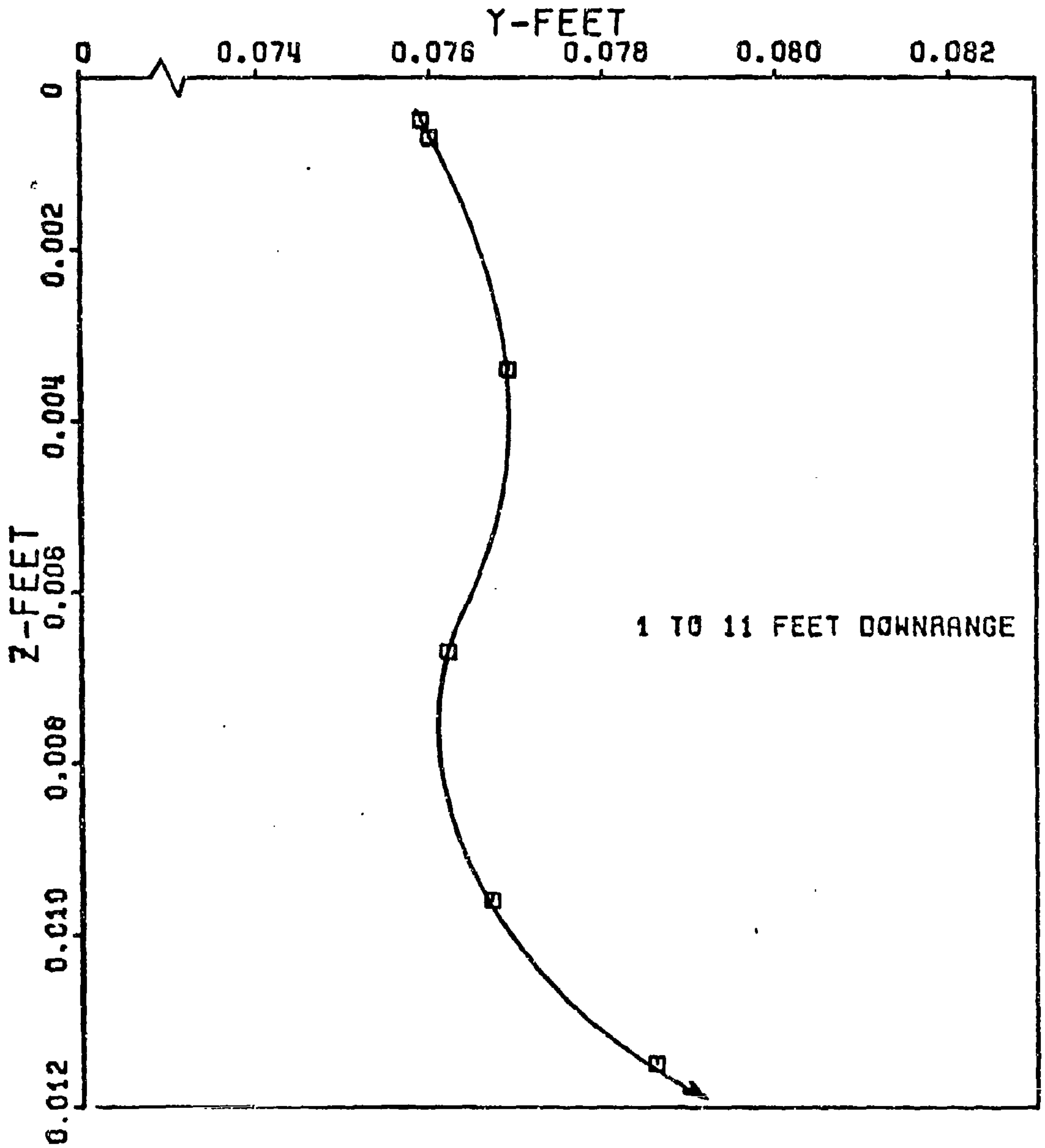


Figure 41. Raw Translational Data Ground Point - Round 16

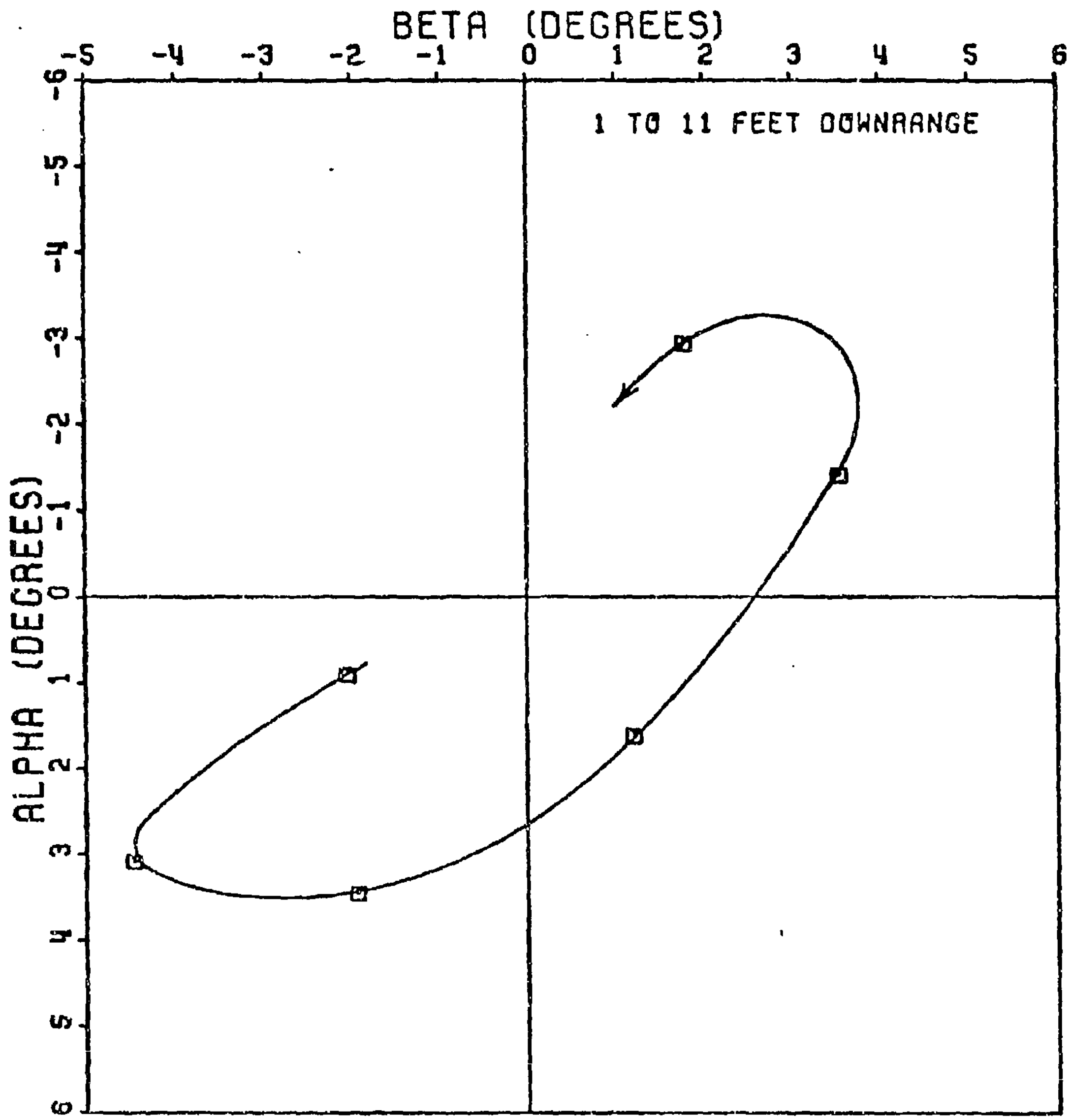


Figure 42. Raw Angular Data Ground Point - Round 16

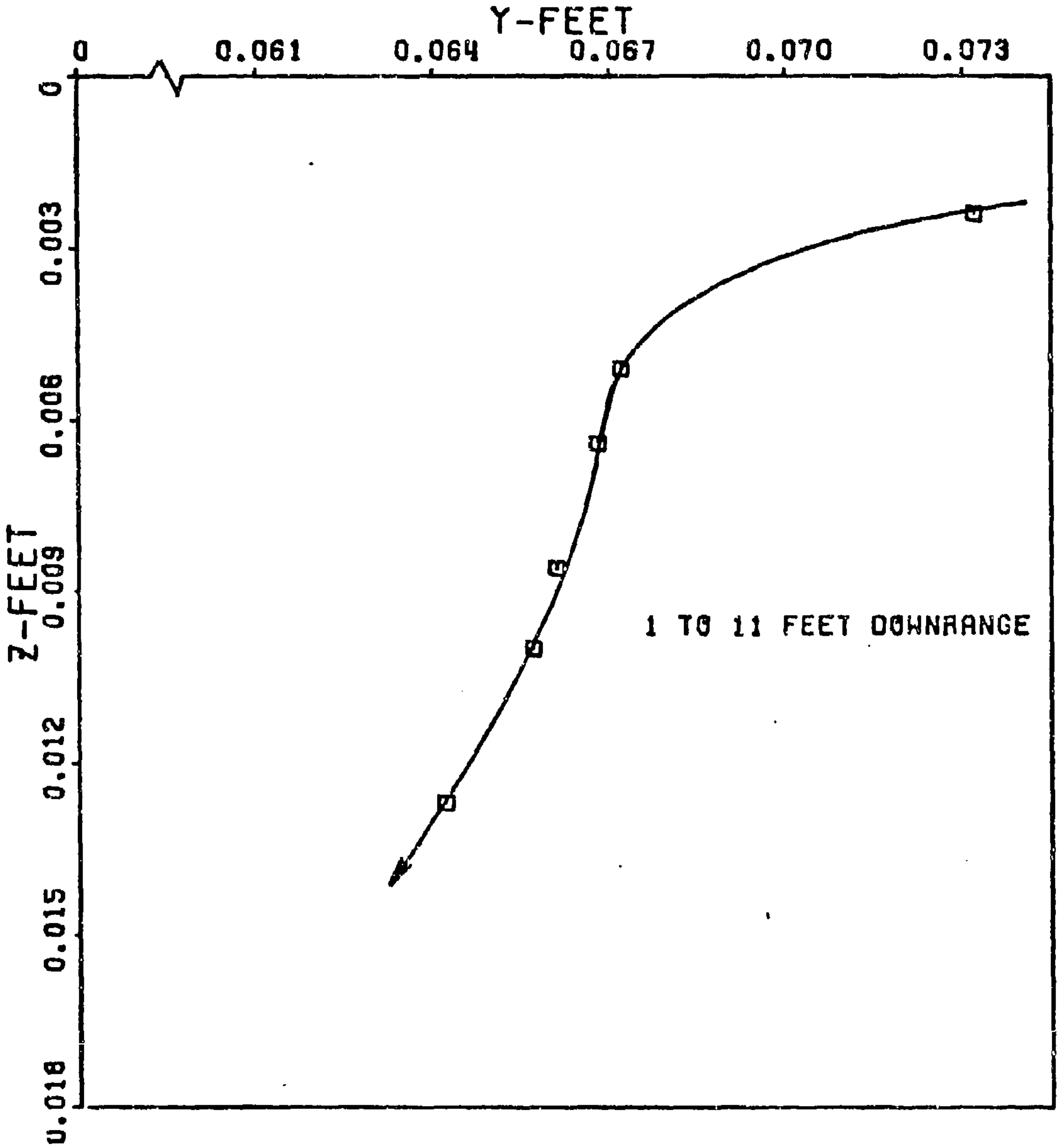


Figure 43. Raw Translational Data Ground Point - Round 17

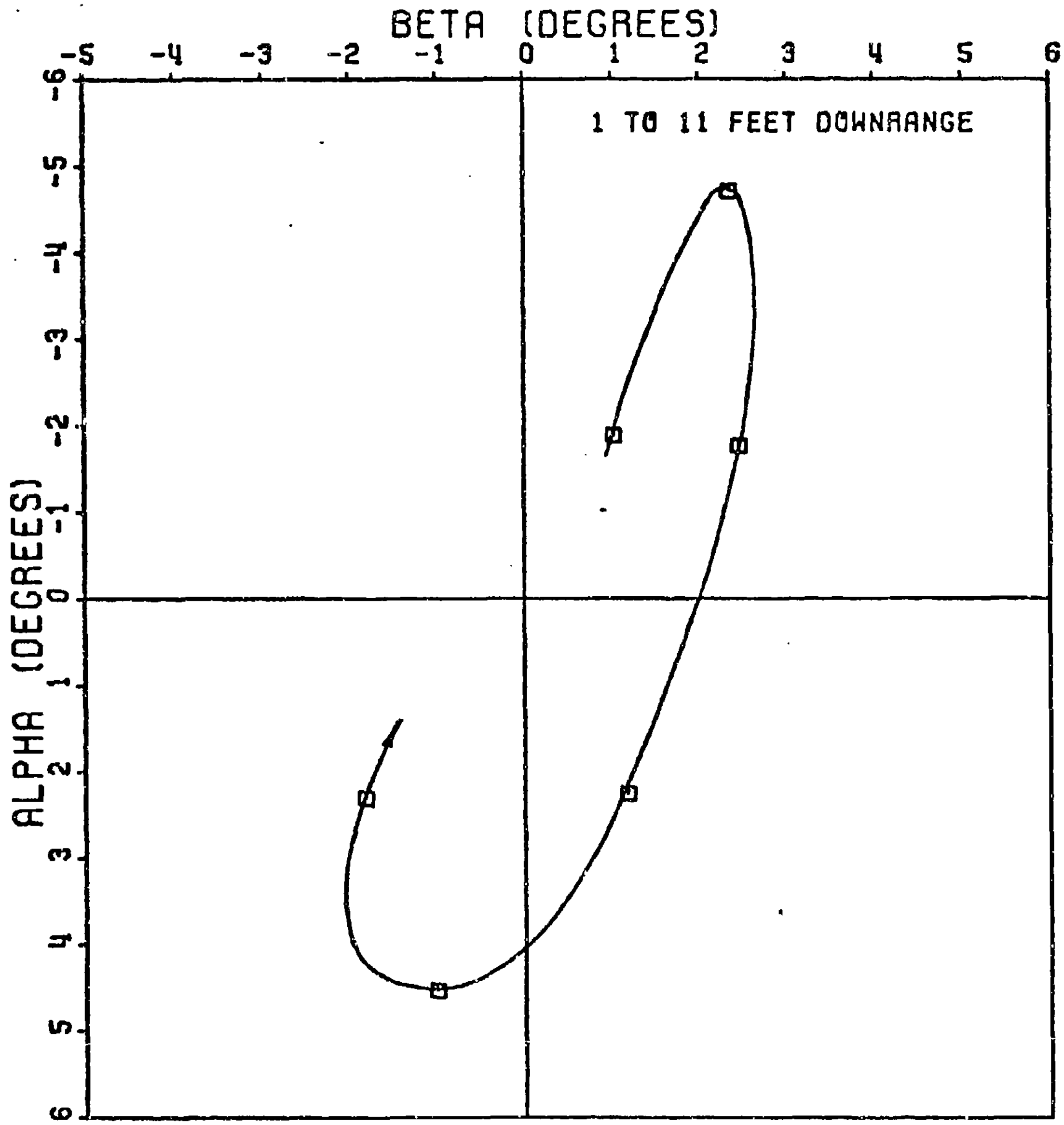


Figure 44. Raw Angular Data Ground Point - Round 17

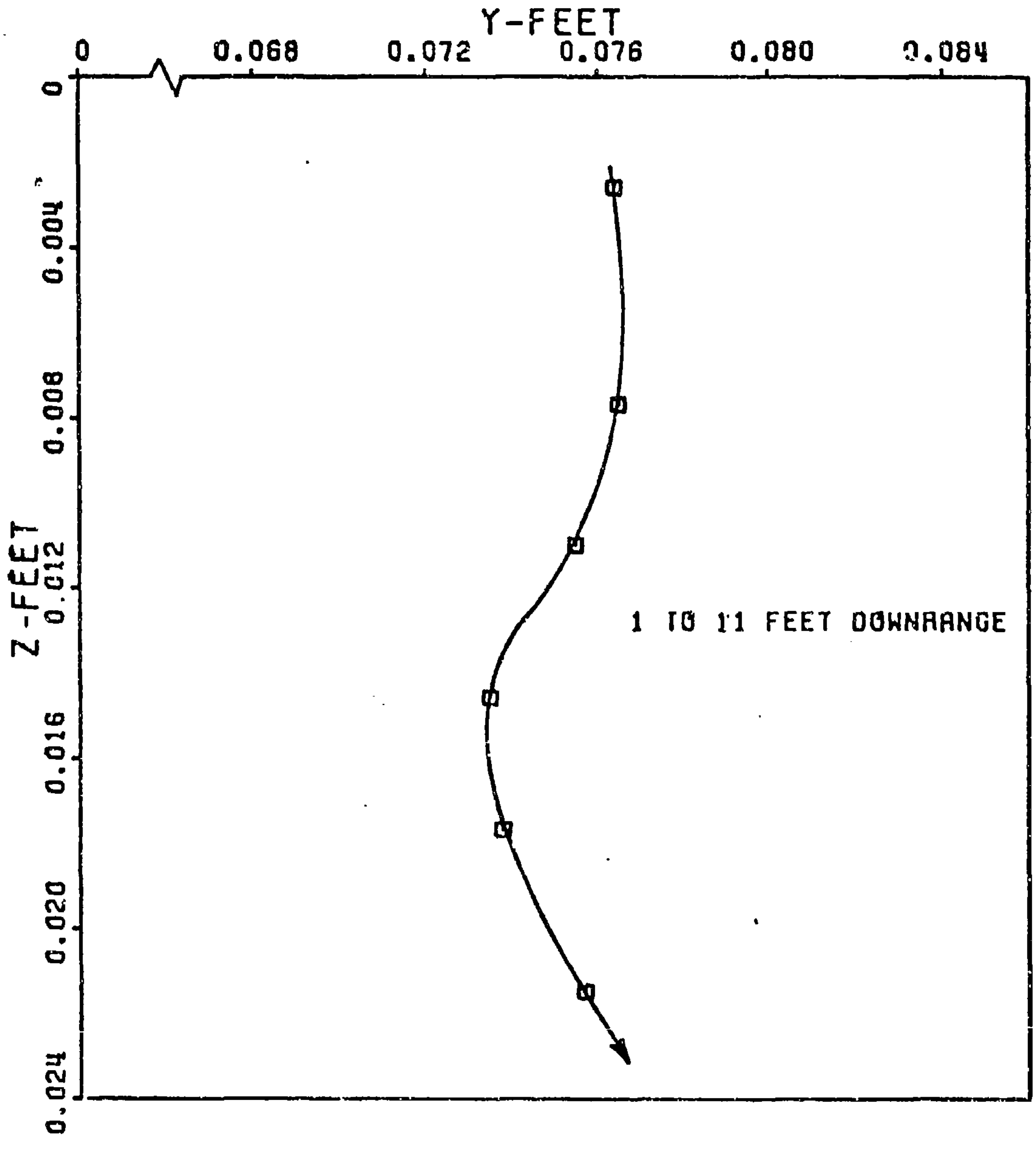


Figure 45. Raw Translational Data Ground Point - Round 19

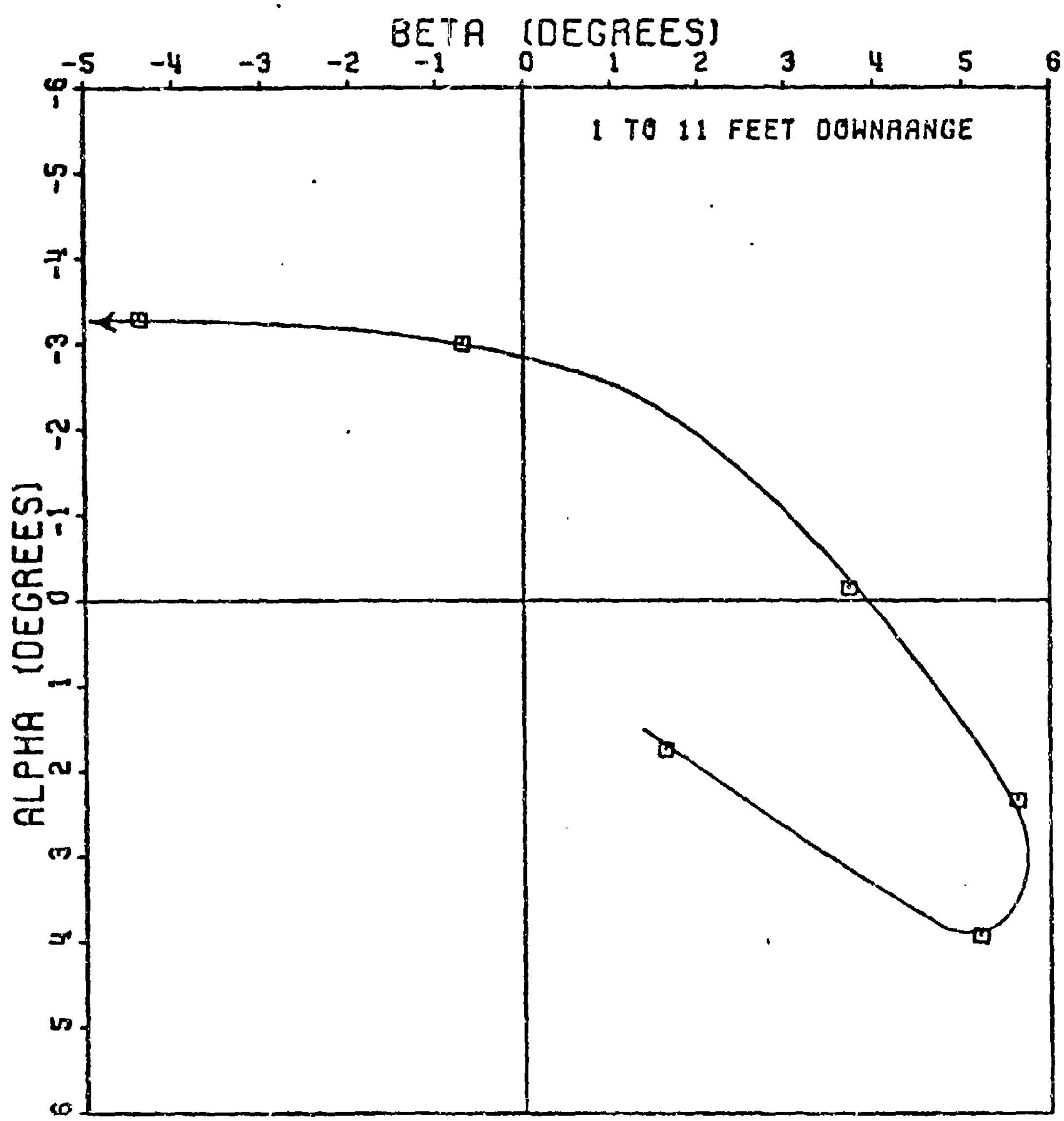


Figure 46. Raw Angular Data Ground Point - Round 19

Once the raw data was obtained, it had to be converted into a form such that initial conditions $\vec{S}_o$, $\dot{\vec{S}}_o$, $\vec{\alpha}_o$ and $\dot{\vec{\alpha}}_o$ could be extracted from it. To eventually arrive at values for $\vec{S}_o$ and $\dot{\vec{S}}_o$, the translational parameters, the raw position or translational data had to be approximated by equations. The raw data was fitted to a polynomial equation of third degree by a least squares method. The data in the y-direction was fit separately from that in the z-direction to distinguish between the swerve and heave contributions. With the equations obtained, a simple differentiation yielded equations for the velocities in the y and z directions. The initial conditions $\vec{S}_o$ and $\dot{\vec{S}}_o$ are now readily obtainable:

$$\vec{S}_o \text{ (ft)} = y_o + iz_o$$
$$\dot{\vec{S}}_o \text{ (ft/sec)} = \dot{y}_o + i\dot{z}_o$$

Obtaining $\vec{\alpha}_o$ and $\dot{\vec{\alpha}}_o$ from the raw angular data was more difficult. The traditional way of analyzing any missile motion with pitch, yaw, and roll is by a three-degree-of-freedom least squares fit to the tricyclic motion, Equation 6. However, the availability of only 6 data points made this technique impossible, so another, approximate method, had to be employed. The solution was to approximate the pitching and yawing motion to one-degree-of-freedom while holding the roll rate constant. In order to do this, the β - α axis system had to be rotated to coincide with the more dominant angular mode. Figure 47 illustrates a typical raw angular data plot. Since the angular motion of the flechette tends to approximate an ellipse, the β - α axes are rotated some angle γ to coincide with the

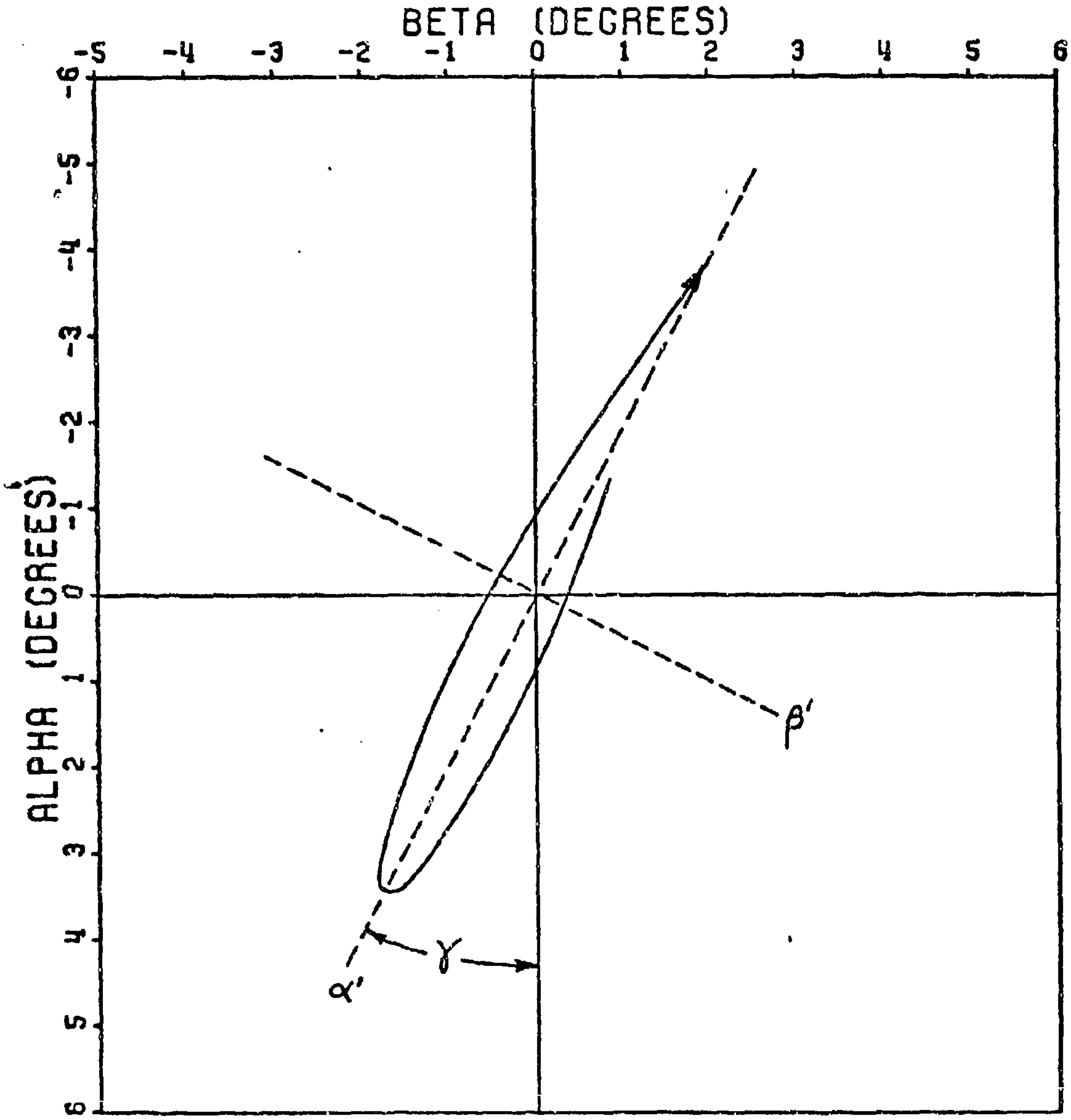


Figure 47. Axis Rotation Approximates Pure Pitching Motion

major and minor axes of the ellipse, as shown. The angular data is retabulated for this new axes system, $\beta' - \alpha'$. To fit the data to the one-degree-of-freedom equation:

$$\alpha = K_1 e^{\lambda t} \cos(\omega t + \delta)$$

only the dominant mode can be considered. For example, in Figure 47 the dominant mode occurs along the α' axis; therefore, only α' coordinates are utilized in the least squares fit, corresponding β' coordinates are ignored. Table XXI lists the parameters obtained for the eight flechette rounds. Once an equation for α' is obtained, it represents one dimensional oscillatory motion along the α' axis. A simple differentiating of the α' equation yields an equation for $\dot{\alpha}'$. The initial conditions $\vec{\alpha}_o$ and $\vec{\dot{\alpha}}_o$, however, are complex whereas α' and $\dot{\alpha}'$ are only one dimensional. Therefore, the rotation angle γ is taken into account and the α' equation is projected back into the β , α axes system:

$$\alpha = \alpha' \cos\gamma$$

$$\dot{\alpha} = \dot{\alpha}' \cos\gamma$$

$$\beta = \alpha' \sin\gamma$$

$$\dot{\beta} = \dot{\alpha}' \sin\gamma$$

Thus the complex initial conditions are approximated.

$$\vec{\alpha}_o = \beta_o + i\alpha_o$$

$$\vec{\dot{\alpha}}_o = \dot{\beta}_o + i\dot{\alpha}_o$$

Figures 48-63 illustrate the fitted data both translational and angular for the eight rounds. The transitional data includes the pertinent equations.

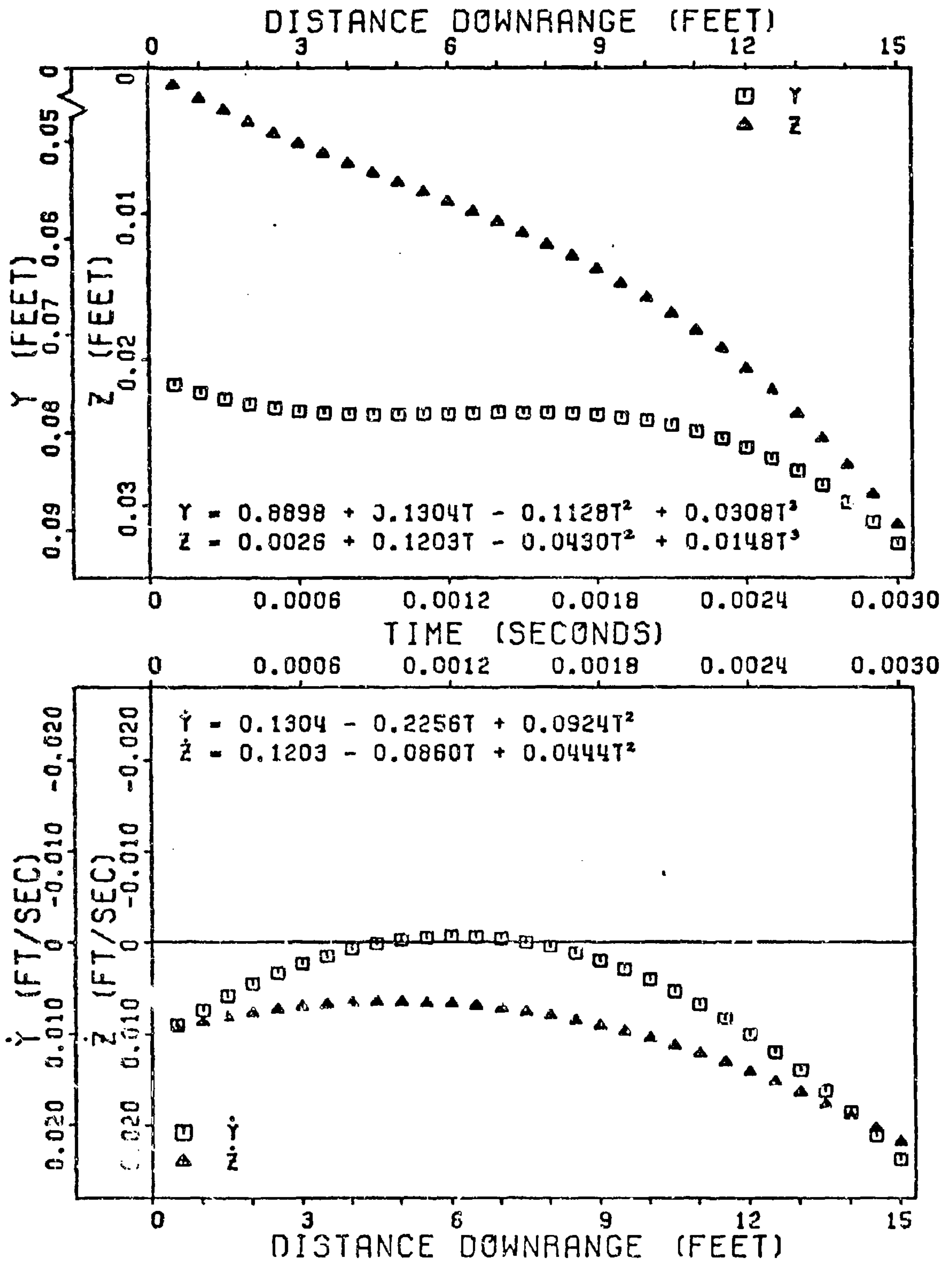


Figure 48. Fitted Translational Data Ground Point - Round 4

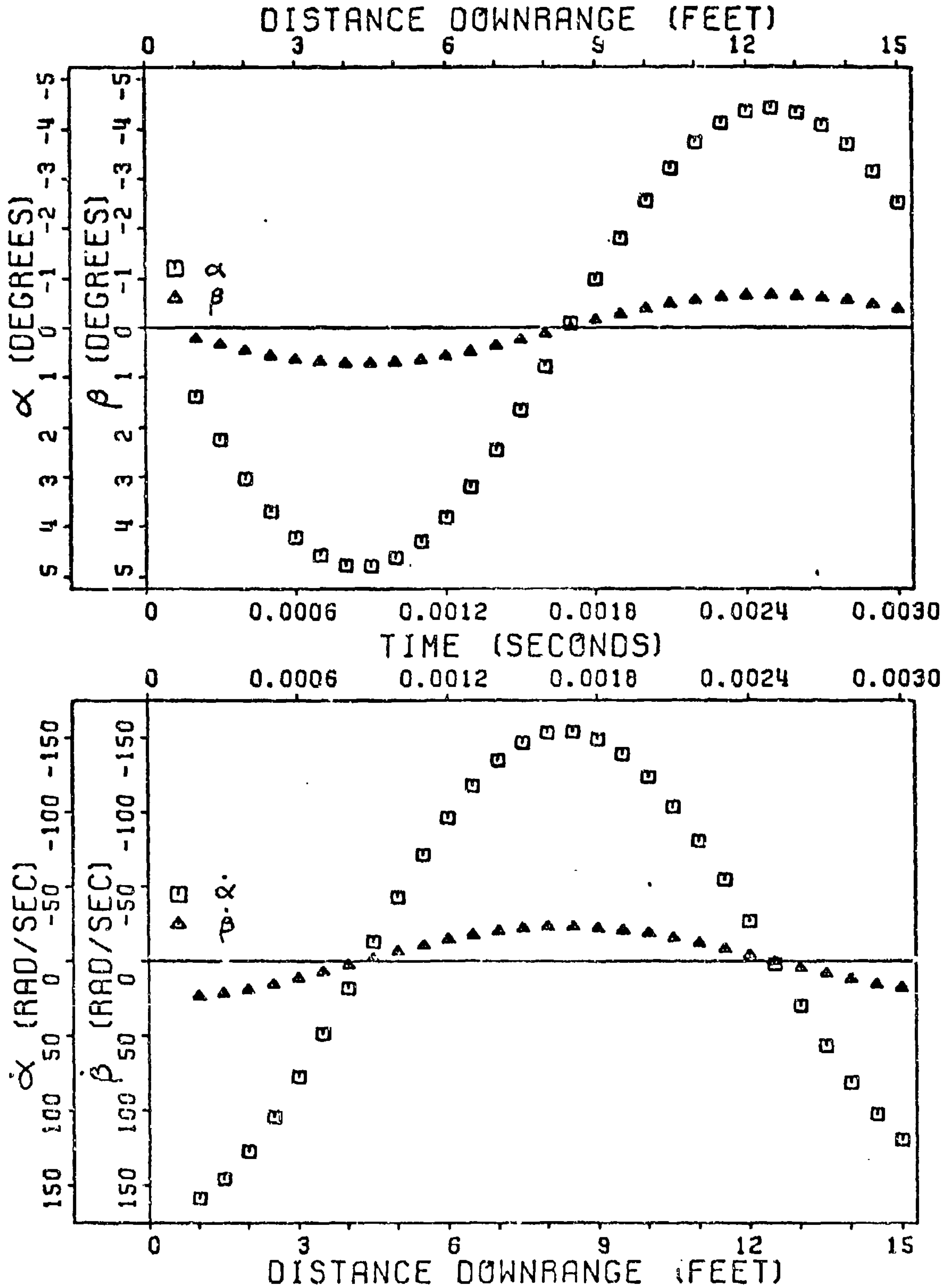


Figure 49. Fitted Angular Data Ground Point - Round 4

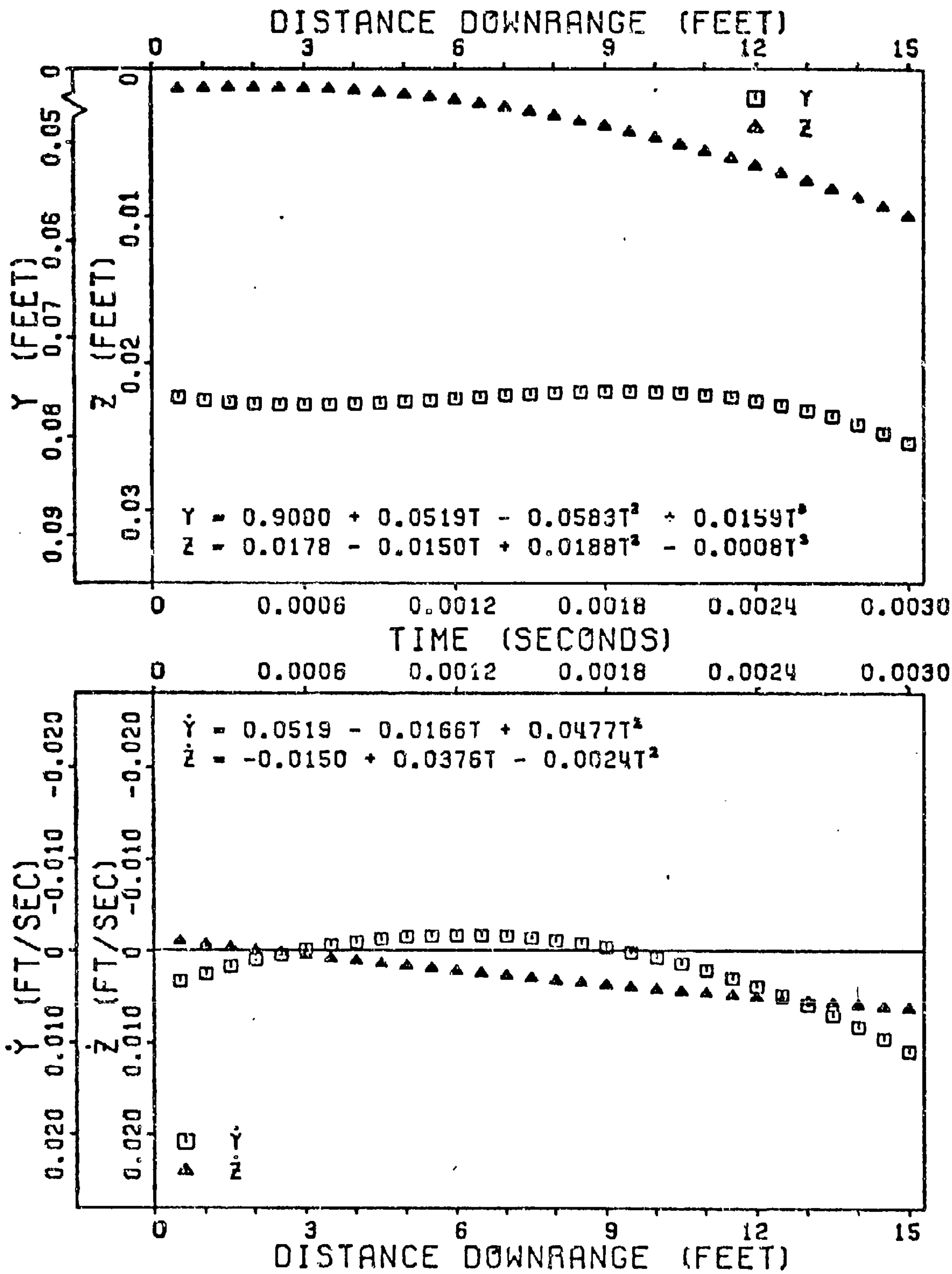


Figure 50. Fitted Translational Data Ground Point - Round 6

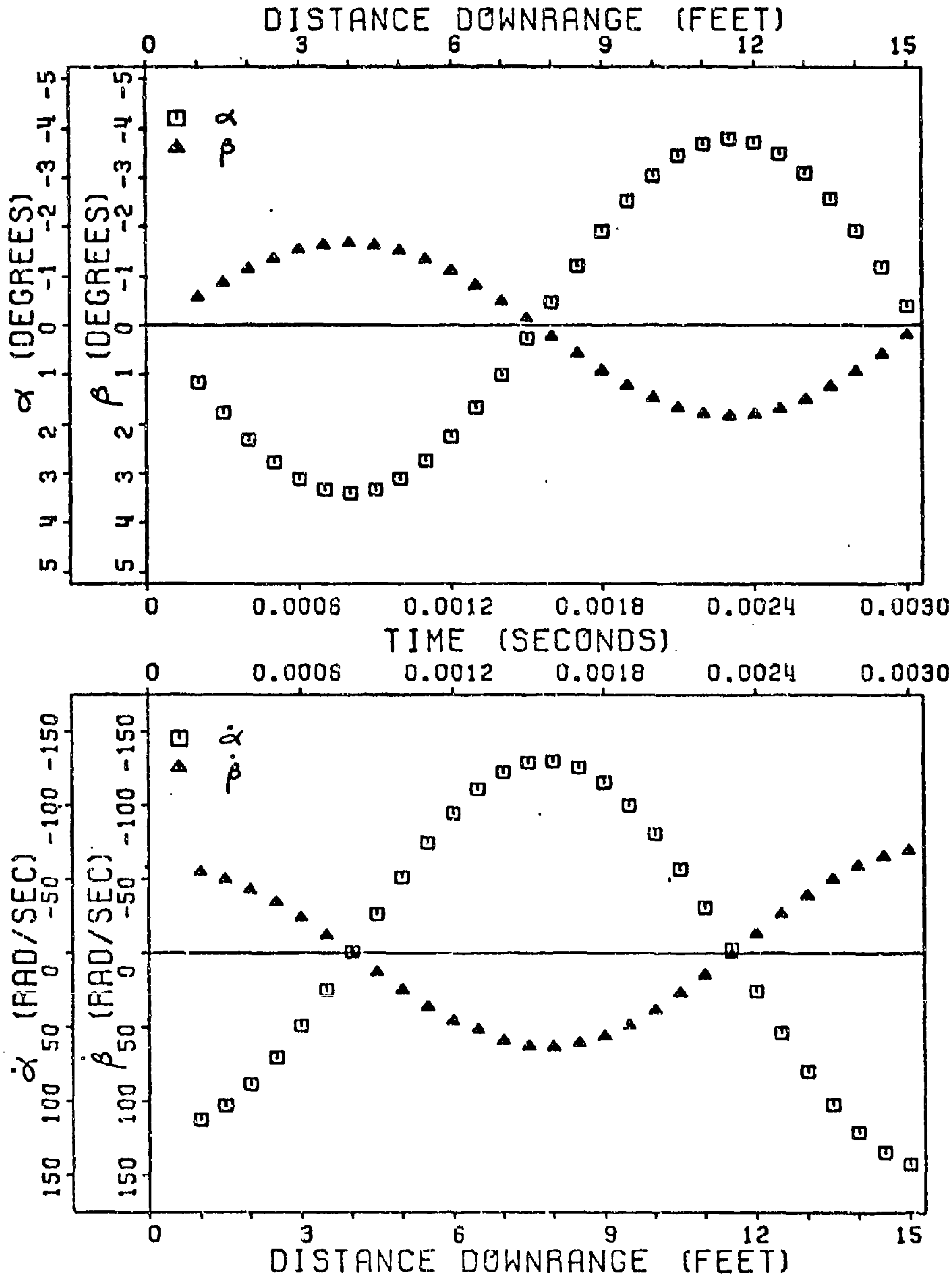


Figure 51. Fitted Angular Data Ground Point - Round 6

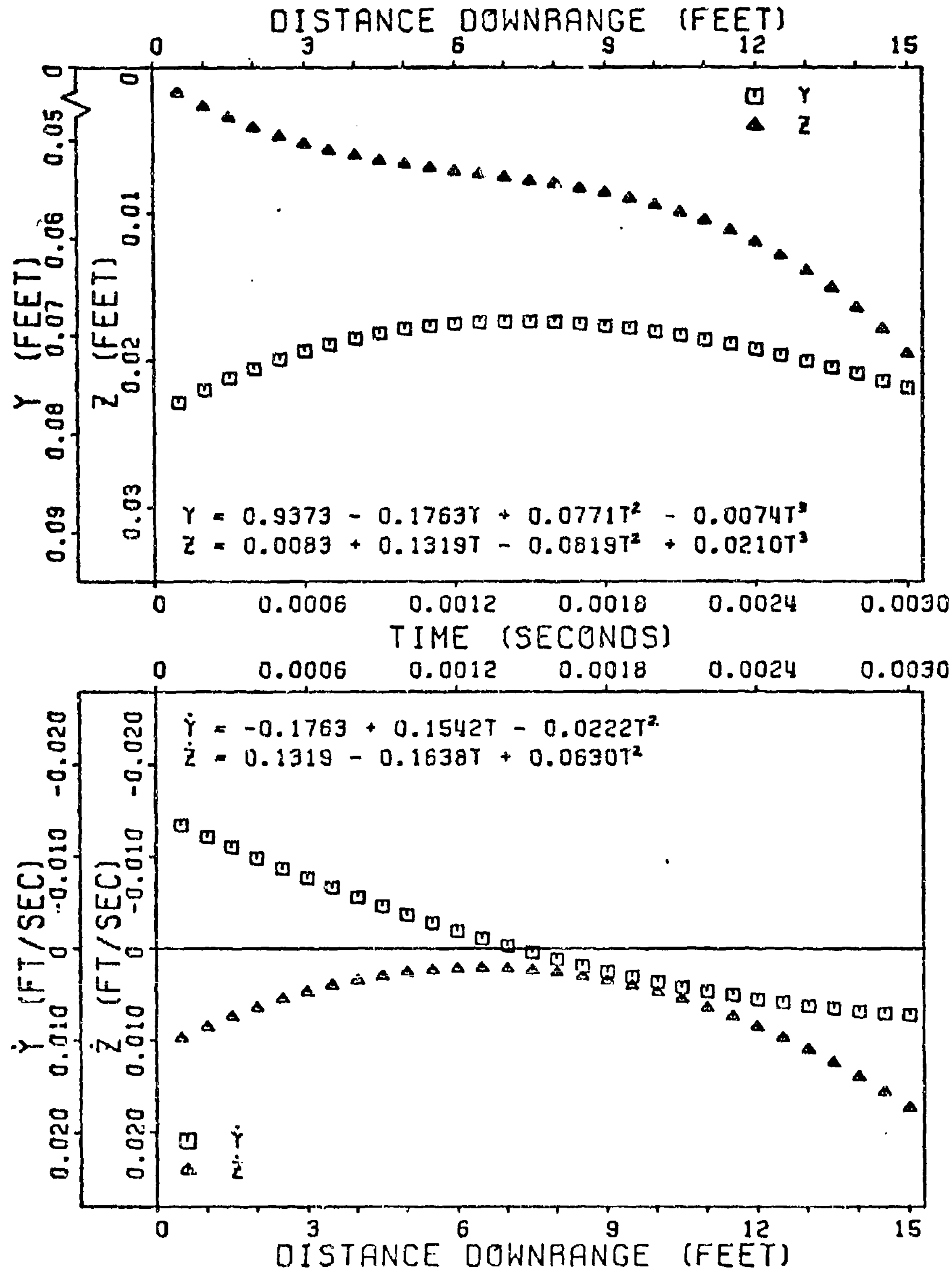


Figure 52. Fitted Translational Data Ground Point - Round 7

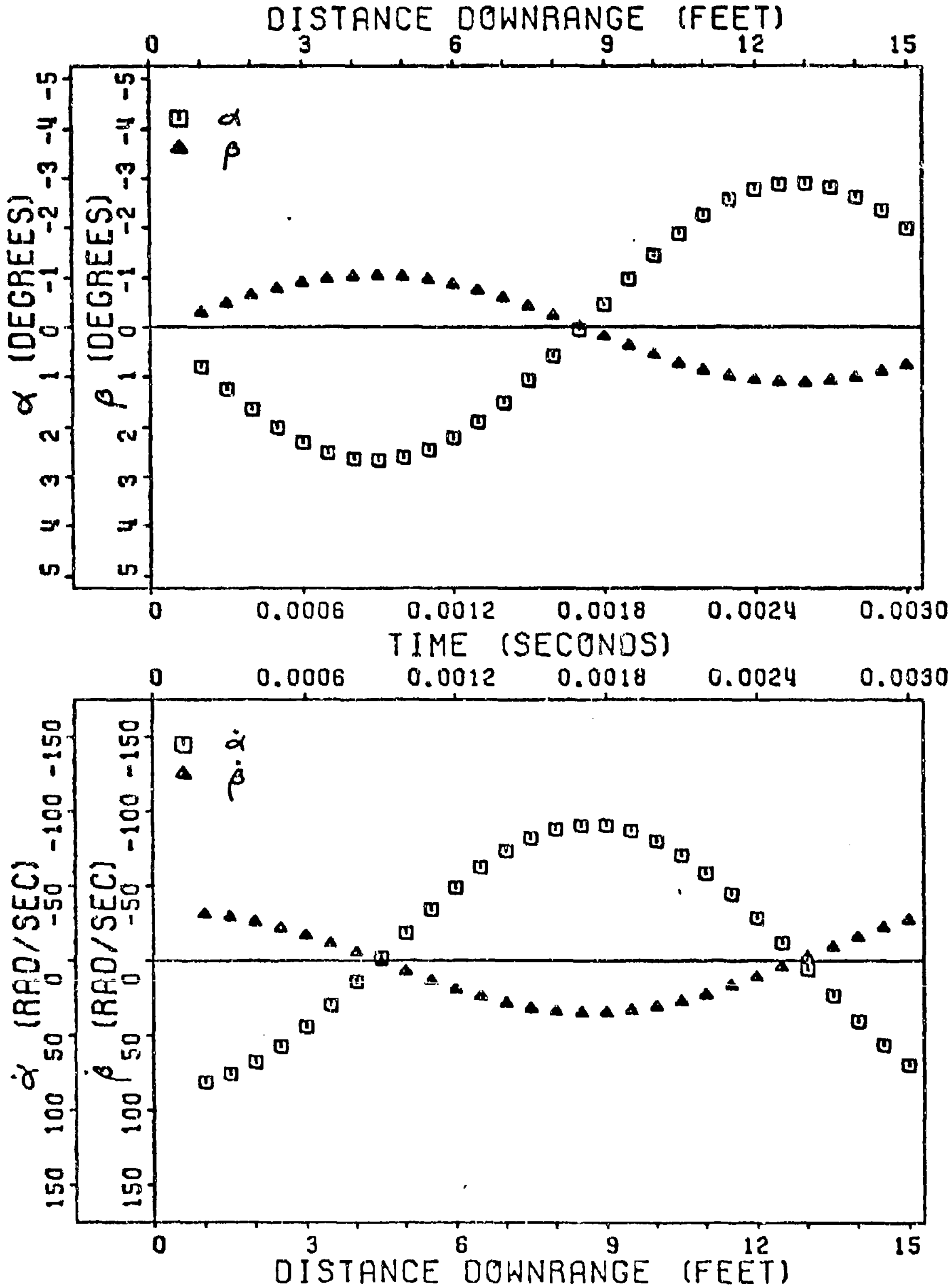


Figure 53. Fitted Angular Data Ground Point - Round 7

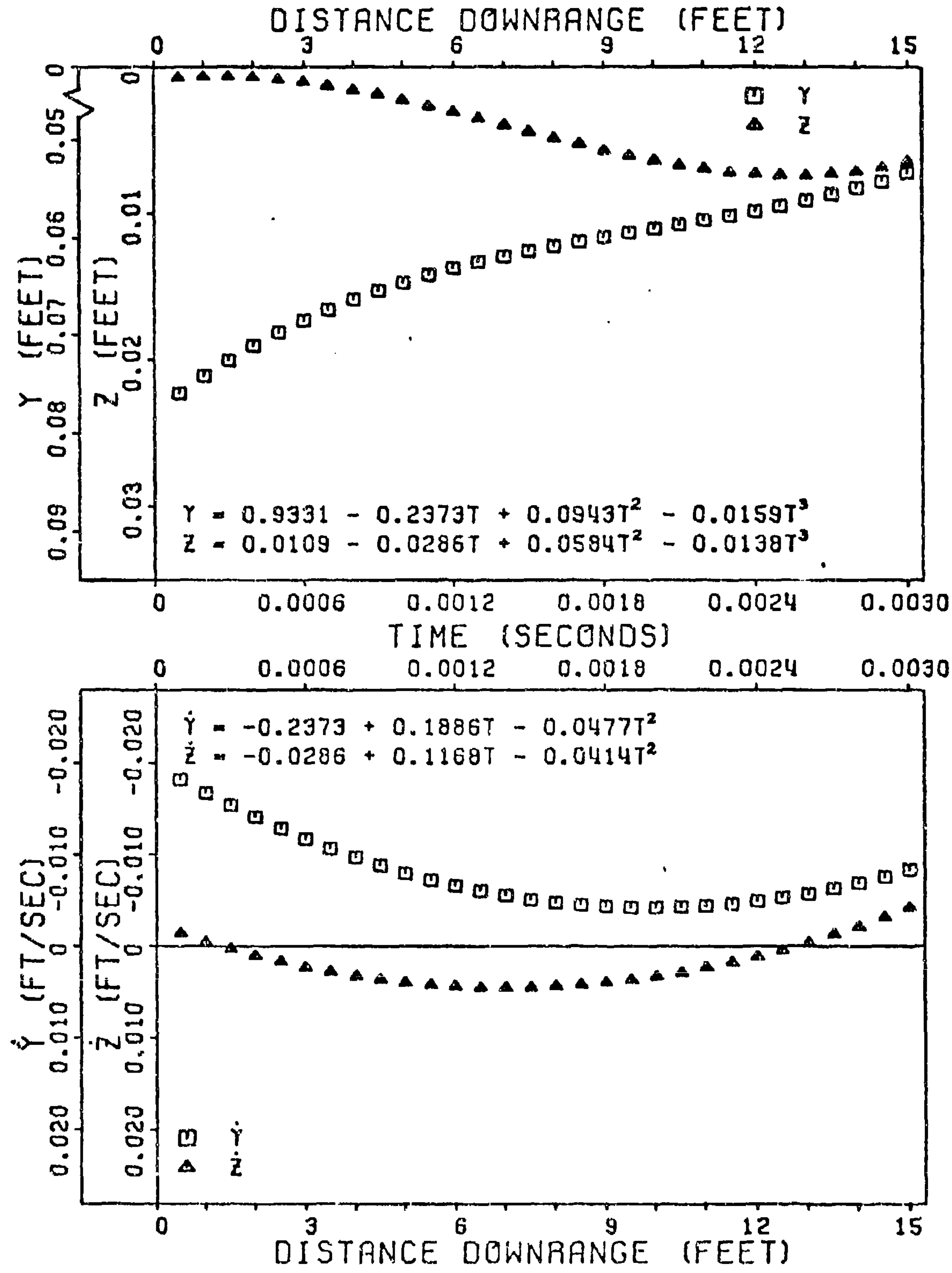


Figure 54. Fitted Translational Data Ground Point - Round 8

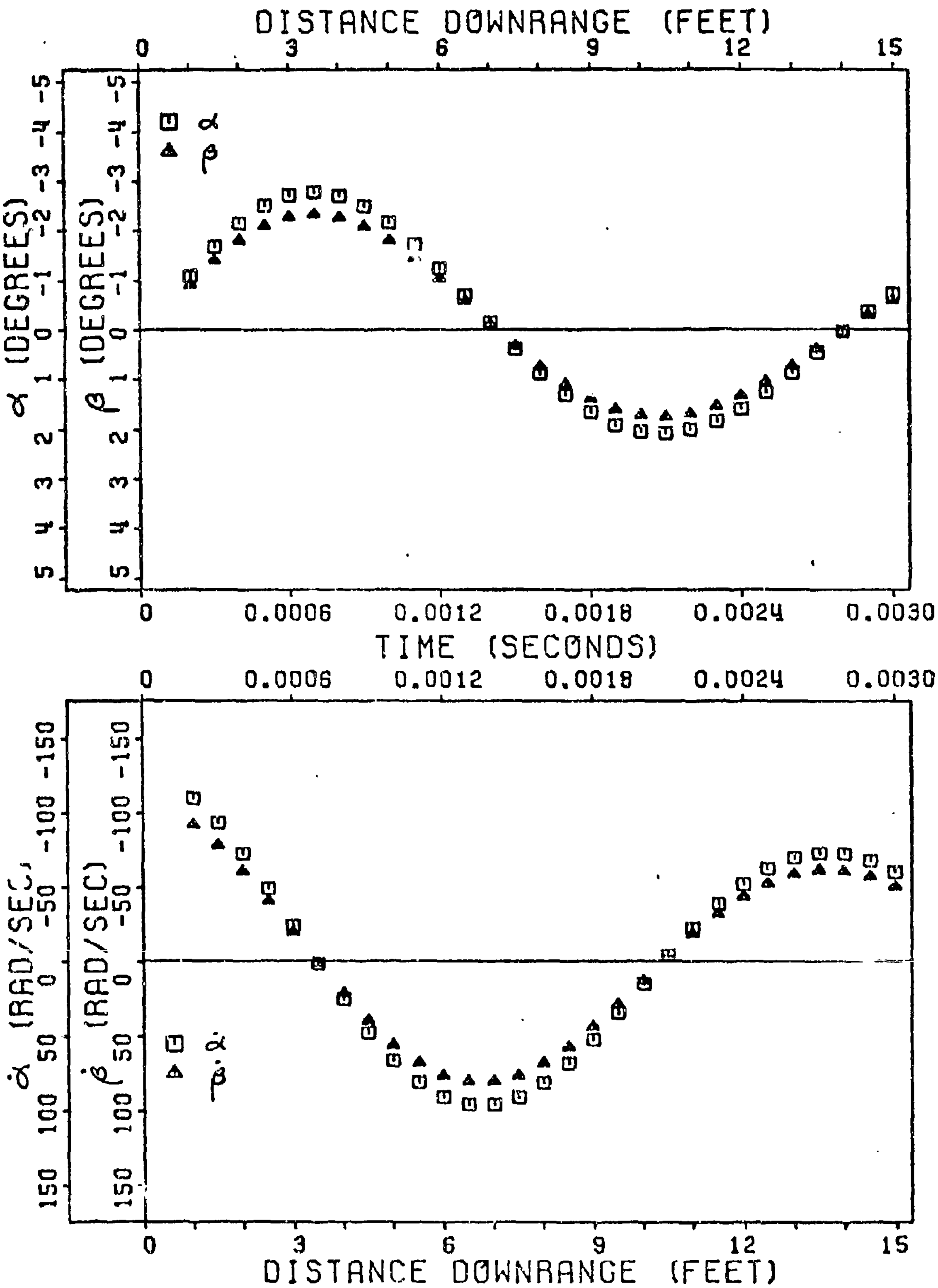


Figure 55. Fitted Angular Data Ground Point — Round 8

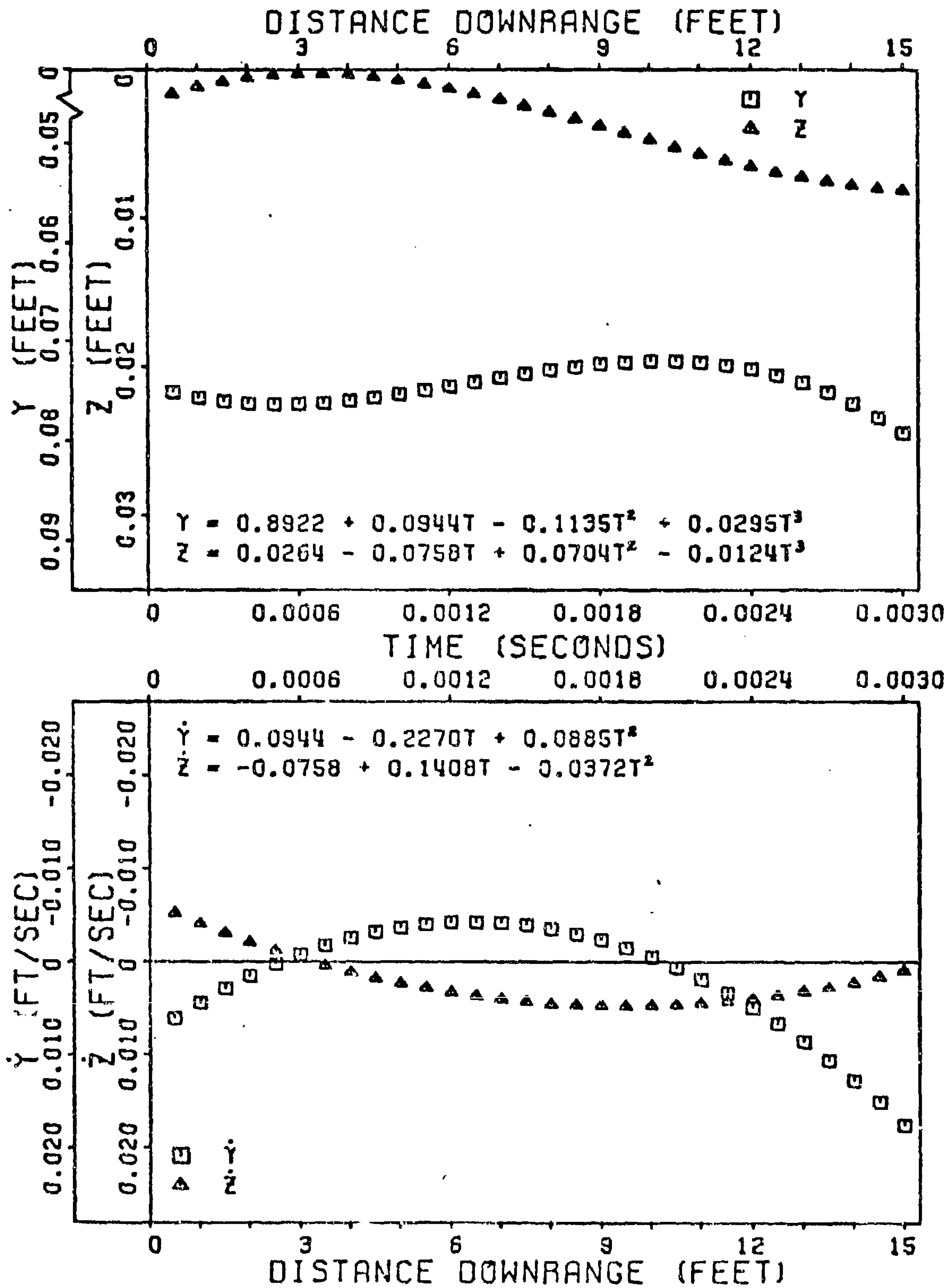


Figure 56. Fitted Translational Data Ground Point -- Round 14

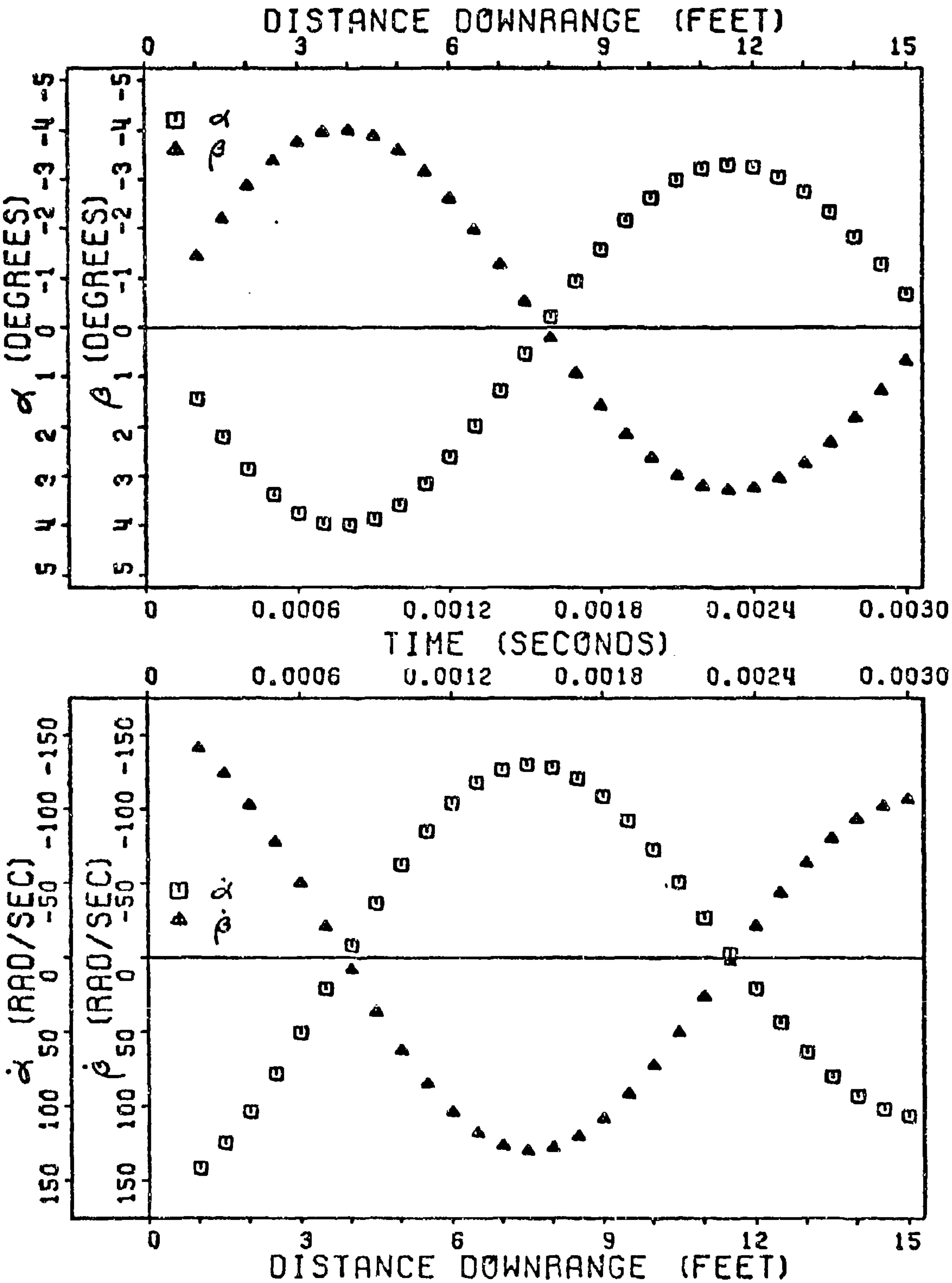


Figure 57. Fitted Angular Data Ground Point - Round 14

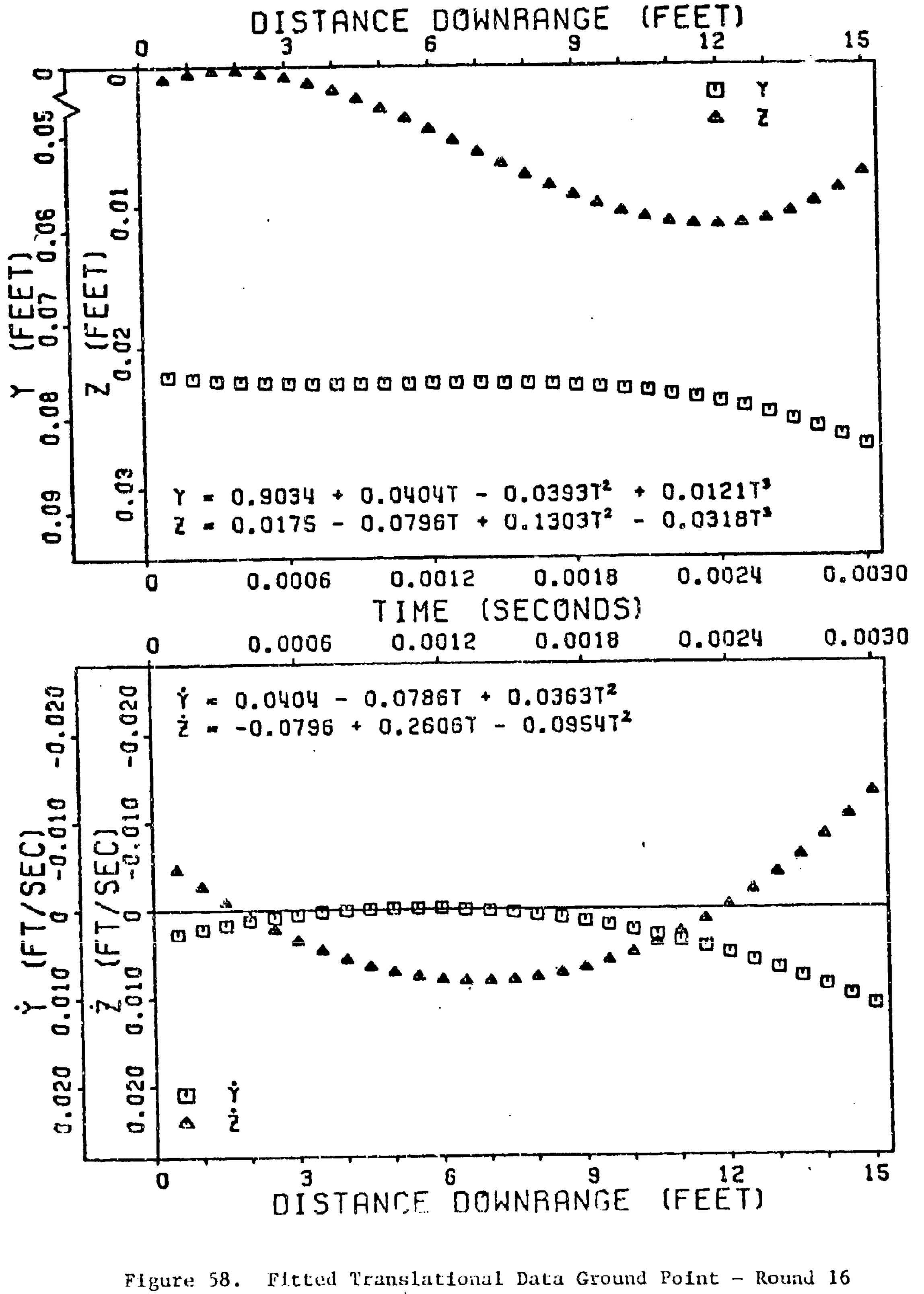


Figure 58. Fitted Translational Data Ground Point - Round 16

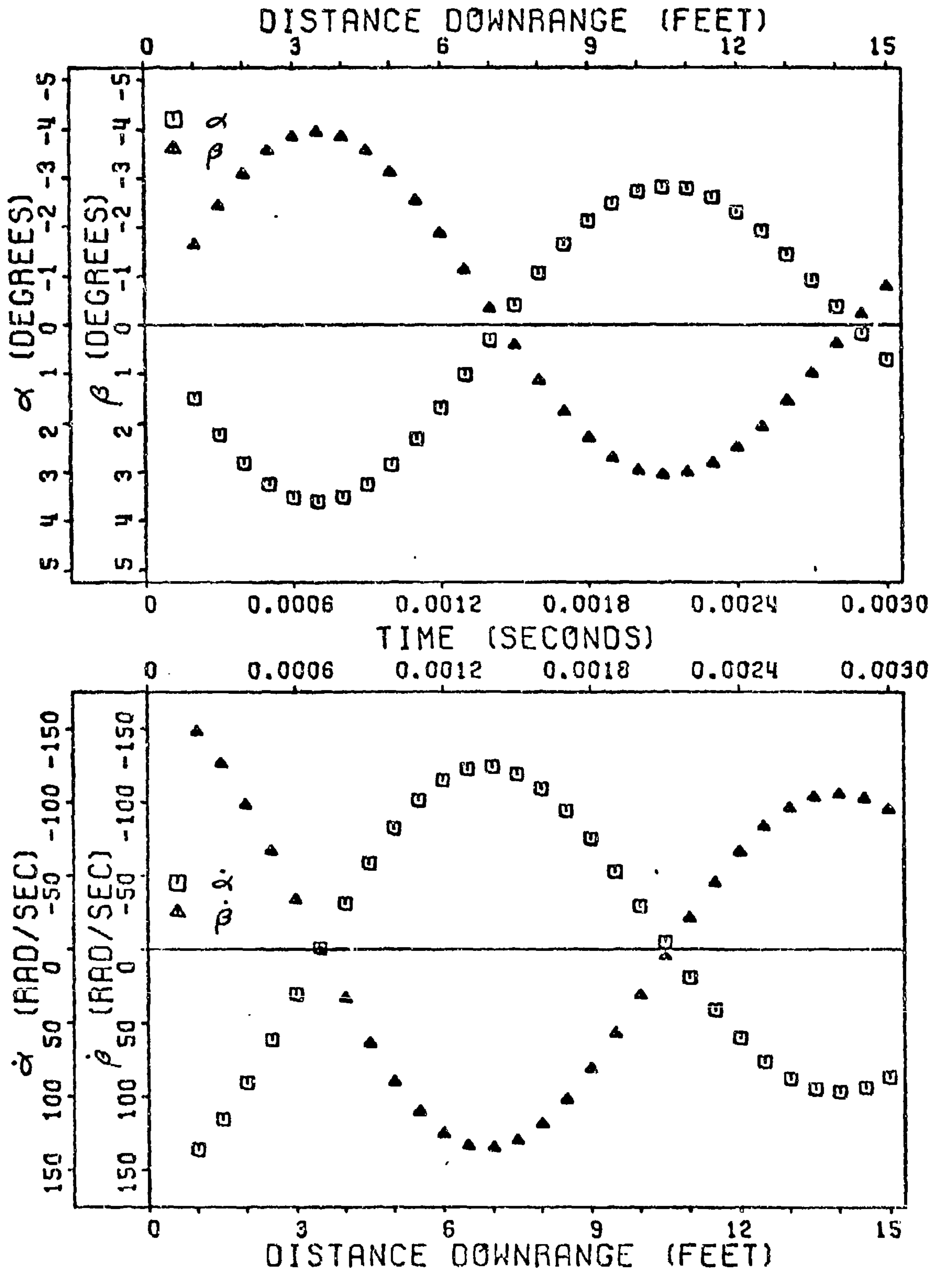


Figure 59. Fitted Angular Data Ground Point - Round 16

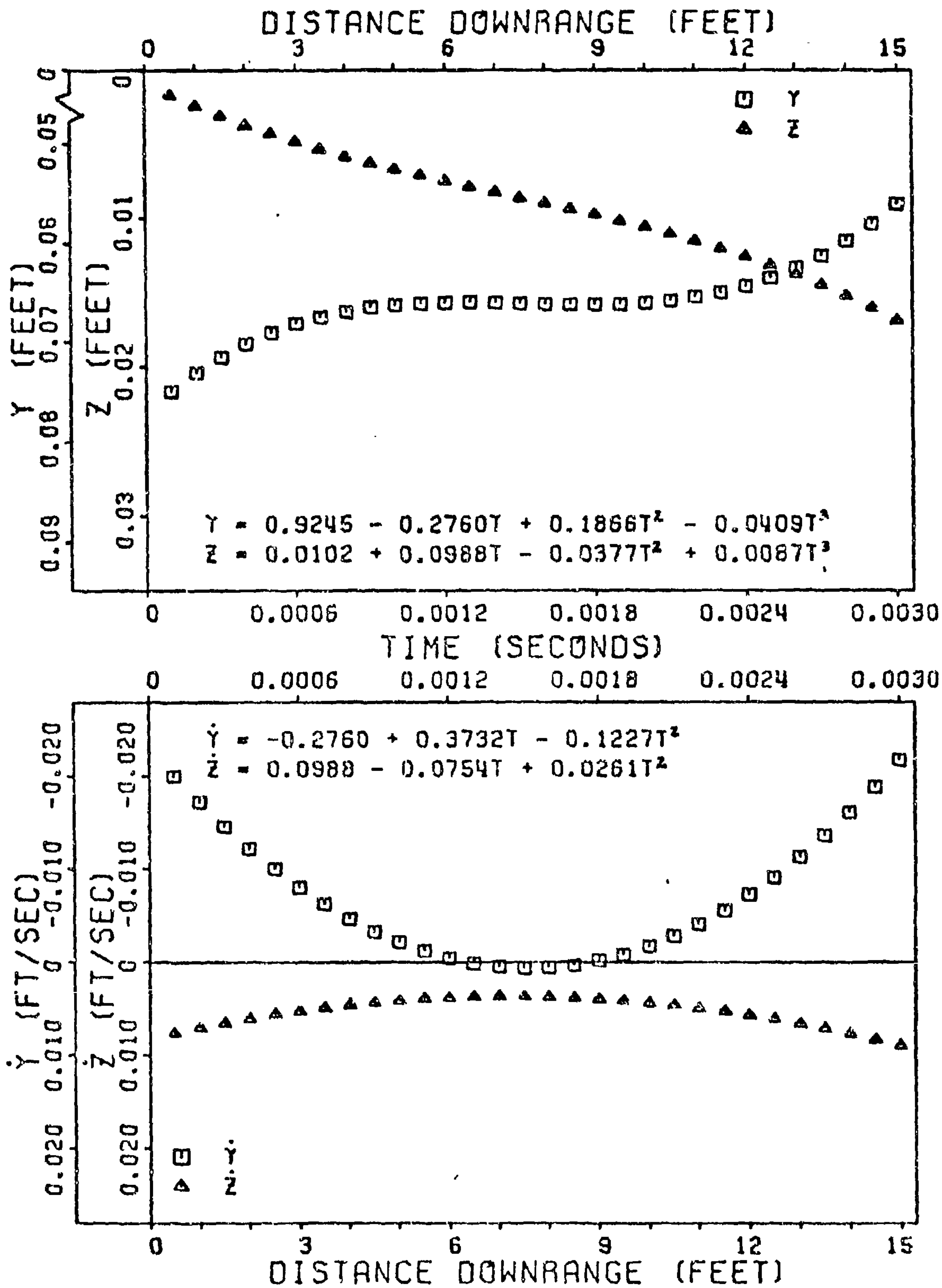


Figure 60. Fitted Translational Data Ground Point - Round 17

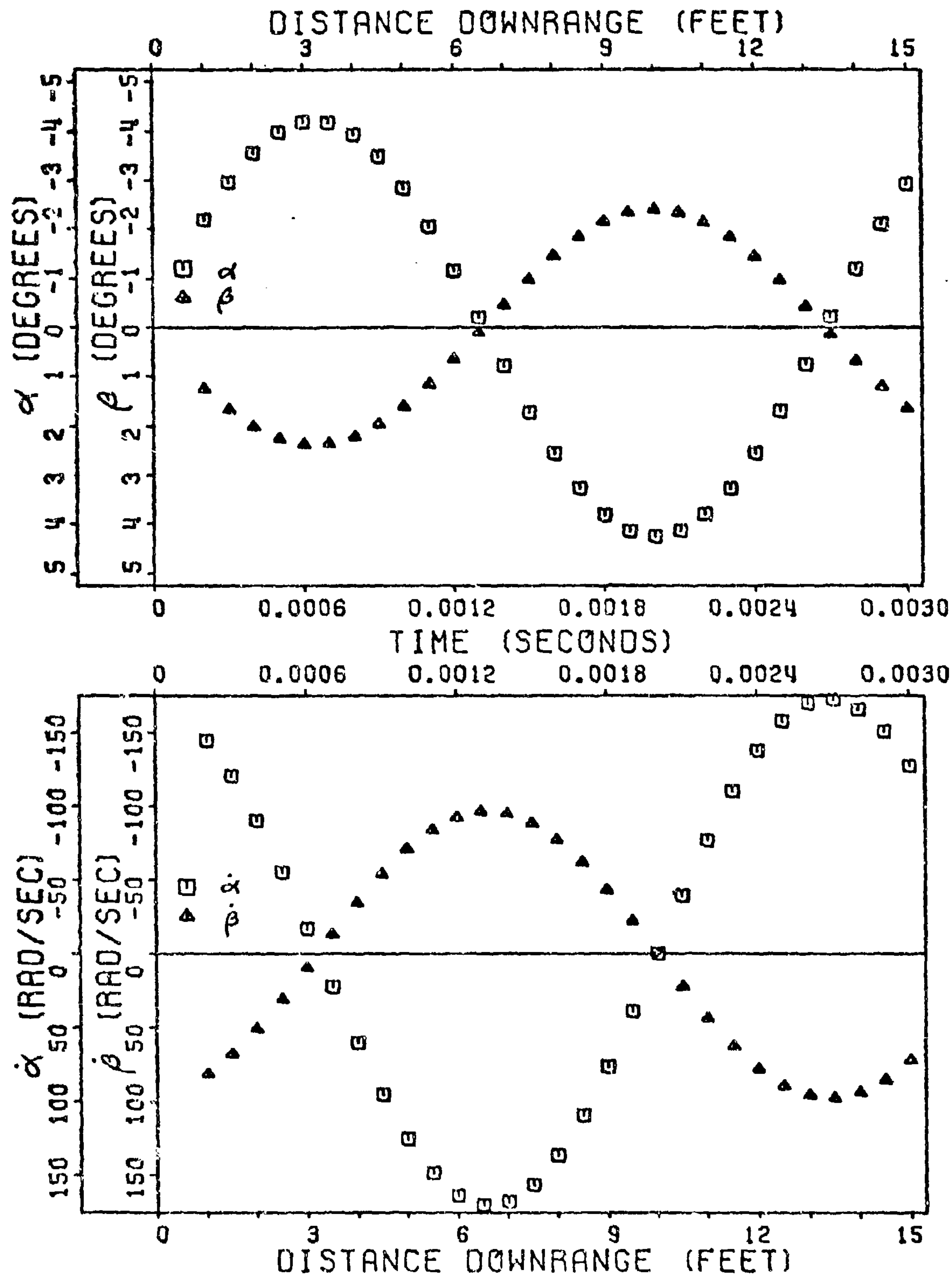


Figure 61. Fitted Angular Data Ground Point - Round 17

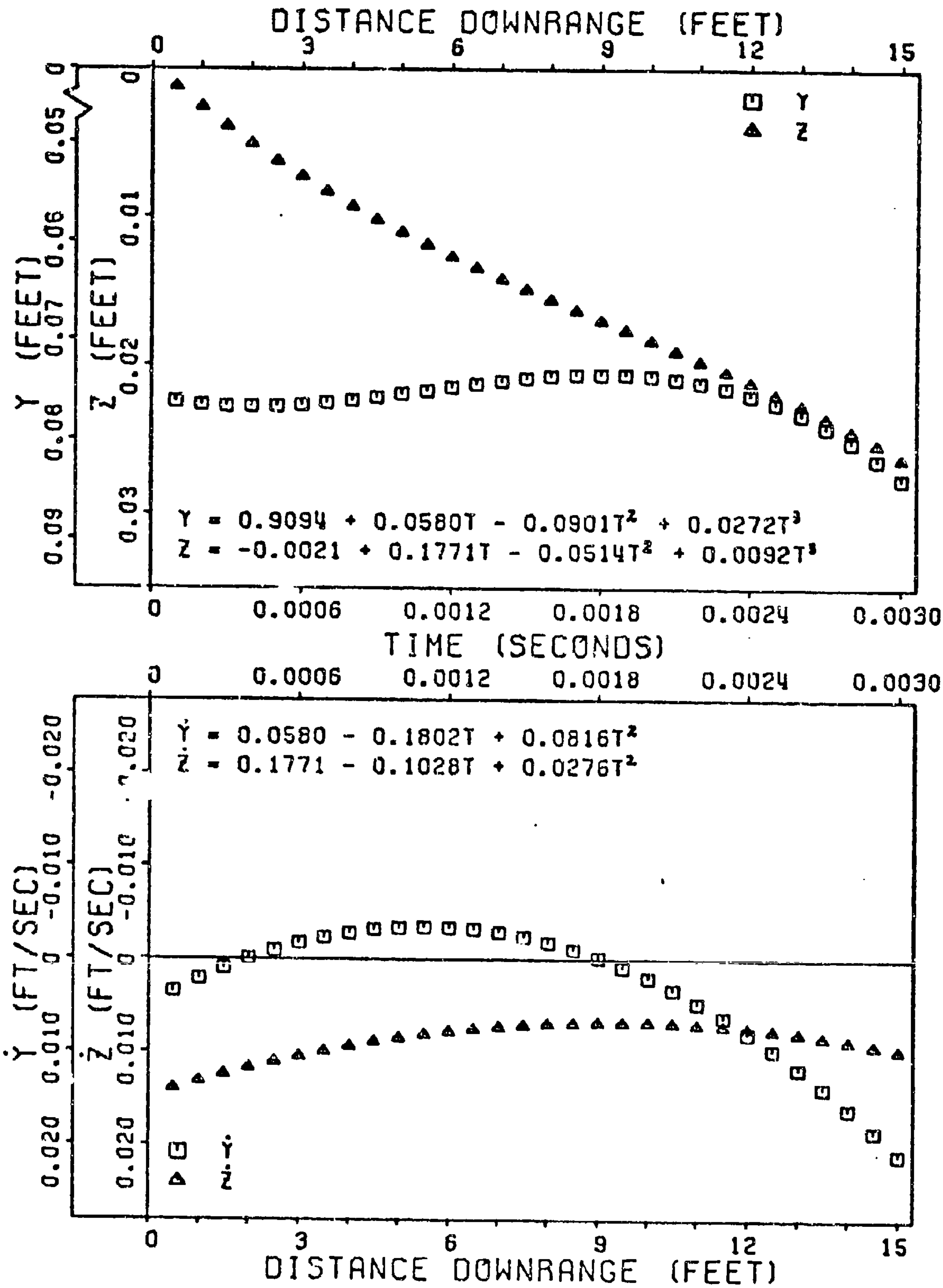
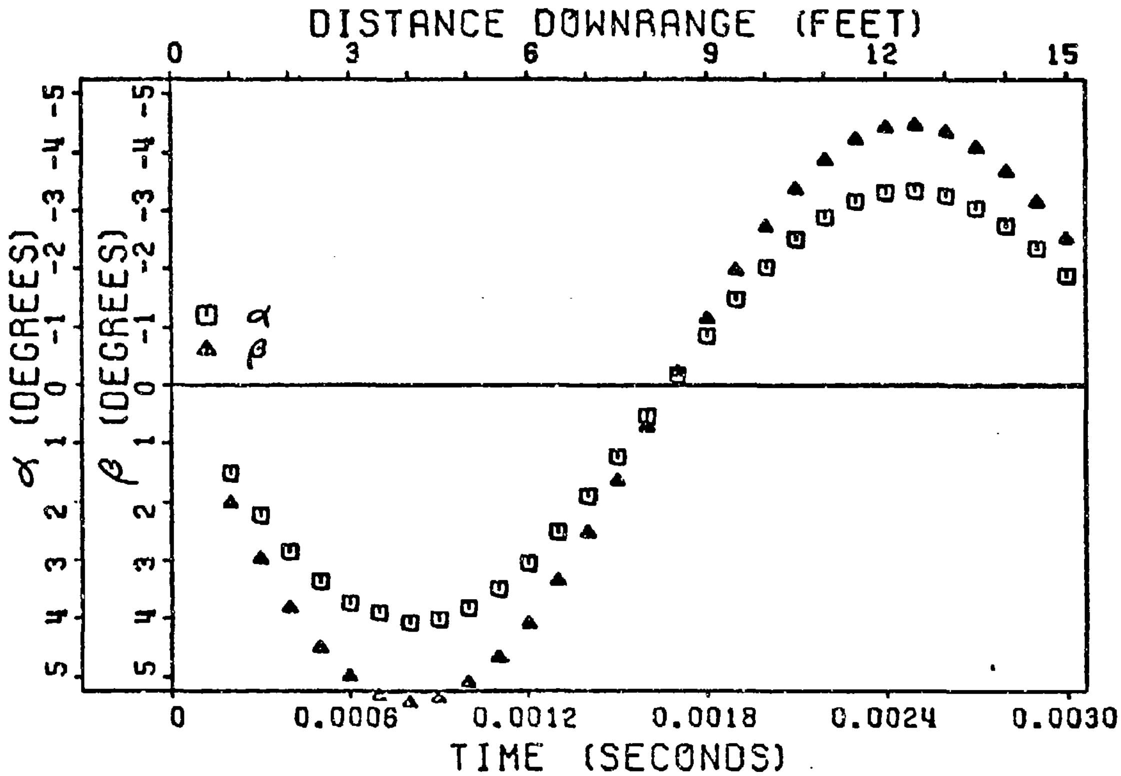


Figure 62. Fitted Translational Data Ground Point - Round 19



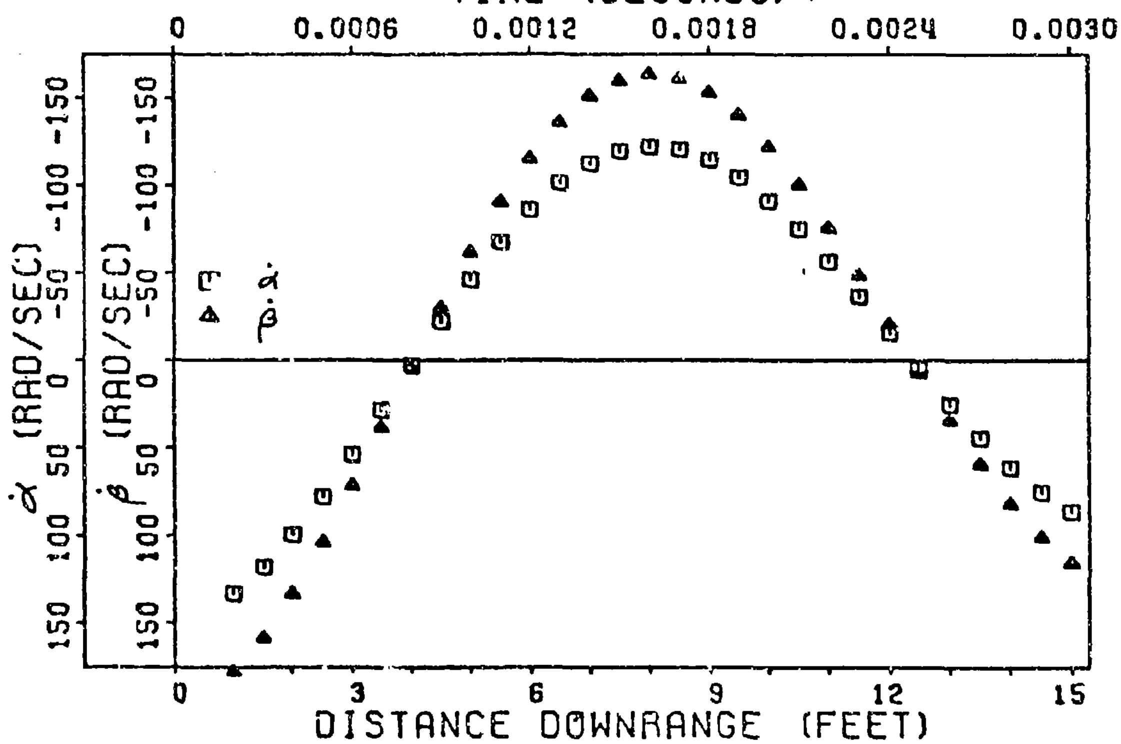


Figure 63. Fitted Angular Data Ground Point - Round 19

TABLE XXI

AERODYNAMIC PARAMETERS FROM LEAST SQUARES FIT

ROUND	K_1 (degrees)	λ (rad/sec)	ω (rad/sec)	δ (rad)
4	5.01	-49.48	1921.3	-1.29
6	3.64	68.24	2079.8	-1.21
7	-2.78	46.48	1871.4	-1.26
8	-4.02	-203.19	2267.6	-1.21
14	6.09	-126.37	2042.0	-1.23
16	5.84	-174.7	2211.7	-1.18
17	-4.81	8.53	2314.5	-1.02
19	7.35	-121.62	1889.9	-1.22

$$\alpha = K_1 e^{\lambda t} \cos(\omega t + \delta)$$

$$\dot{\alpha} = K_1 e^{\lambda t} \left[\lambda \cos(\omega t + \delta) - \omega \sin(\omega t + \delta) \right]$$

DISPERSION ANALYSIS

Free Flight vs Theory

Once the initial conditions are determined as in the previous section, they are applied to the theory and compared to the dispersion of each test fired round. To utilize the theory, the fitted data must be chosen for a given time; that is, $\overrightarrow{S_0}$, $\overrightarrow{\dot{S}_0}$, $\overrightarrow{\alpha_0}$, $\overrightarrow{\dot{\alpha}_0}$ must be selected for one given point in time - position downrange. Since the question of what point in time do the initial conditions occur, 3 sets of initial conditions were chosen to correspond with positions 1, 3, 5 feet downrange. This span of position downrange may or may not be sufficient to include the actual time corresponding to the initial conditions for each round. The following analysis will determine each round's effective time for its initial conditions.

For each set of initial conditions, theory and 6-D computations were done and compared to target data for the Frankford test firings. The results are tabulated in Table XXII in mils and plotted in Figures 64-71 in feet; deviation from the time of fire at 50 ft. downrange. The relationship between the deviations in feet and mils at 50 ft. downrange is:

$$\overrightarrow{J.A.}\ (\text{mils}) = \frac{\overrightarrow{S}(\text{ft})}{x}\ (1000)$$

or

$$\overrightarrow{J.A.}\ (\text{mils}) = (20)\ \overrightarrow{S}(\text{ft})$$

To accurately and concisely analyze the complex and large amount of data in Table XXII, the positions downrange in which the initial conditions were selected must be simultaneously analyzed with the dispersion results at 50 ft downrange. The problem in choosing initial conditions is where they should be taken; at what point downrange. Normally, one would think

TABLE XXII

DISPERSION ANALYSIS RESULTS

ROUND	Position Downrange (ft)	Initial Conditions u_0 (ft/sec)	p_0 (rad/sec)	$\vec{S_0}$ (ft)	$\dot{\vec{S_0}}$ (ft/sec)	$\vec{\alpha_0}$ (deg)	$\dot{\vec{\alpha_0}}$ (rad/sec)	Frankford Dispersion $\vec{mils}$	$\|mils\|$	Theory Dispersion $\vec{mils}$	$\|mils\|$	6-D Dispersion $\vec{mils}$	$\|mils\|$
	1			0.075968+ 0.002088i	0.007415+ 0.008740i	0.2045+ 1.3732i	23.60+ 158.46i			1.329- 1.302i	1.861	1.300- 1.100i	1.703
4	3	4747	11454	0.077840+ 0.005208i	0.002359+ 0.007057i	0.6273+ 4.2125i	11.54+ 77.57i	2.333- 0.750i	2.451	1.413- 0.529i	1.508	1.380- 0.480i	1.461
	5			0.078183+ 0.007892i	-0.000233+ 0.006558i	0.6877+ 4.6184i	-6.41 -43.04i			1.571+ 0.578i	1.674	1.520+ 0.420i	1.577
	1			0.076348+ 0.001295i	0.002541- 0.000631i	-0.5633+ 1.1550i	-54.86+ 112.48i			2.001- 0.944i	2.213	2.100- 0.920i	2.293
6	3	4662	13201	0.076799+ 0.001283i	0.000074+ 0.000558i	-1.5239+ 3.1247i	-23.78+ 48.77i	1.050- 0.200i	1.069	1.709- 0.390i	1.753	1.760- 0.360i	1.796
	5			0.076458+ 0.001733i	-0.001417+ 0.001683i	-1.5145+ 3.1055i	25.01- 51.29i			1.268+ 0.509i	1.367	1.340+ 0.240i	1. 361
	1			0.075422+ 0.002631i	-0.012196+ 0.008472i	-0.3073+ 0.7927i	-31.50+ 81.24i			1.777- 0.638i	1.888	1.820- 0.520i	1.893
7	3	4642	14219	0.071473+ 0.005208i	-0.007648+ 0.004692i	-0.8928+ 2.3027i	-17.09+ 44.08i	2.817- 0.083i	2.818	1.550- 0.263i	1.572	1.560- 0.200i	1.573
	5			0.069225+ 0.006608i	-0.003692+ 0.002592i	-1.0138+ 2.6149i	7.18- 18.52i			1.285+ 0.520i	1.386	1.340+ 0.220i	1.358
	1			0.074107+ 0.000617i	-0.016791- 0.000575i	0.9121 1.0872i	-92.44- 110.17i			2.314+ 1.018i	2.527	2.060+ 0.840i	2.225
8	3	4662	12998	0.068436+ 0.000982i	-0.011776+ 0.002215i	-2.2737- 2.7099i	-20.06- 23.91i	1.067+ 1.983i	2.249	1.577+ 0.242i	1.596	1.600+ 0.260i	1.621
	5			0.064517+ 0.002242i	-0.008033+ 0.003900i	-1.8075- 2.1544i	55.78+ 66.48i			0.819- 0.530i	0.975	0.980- 0.340i	1.037
	1			0.075565+ 0.001163i	0.004378- 0.004094i	-1.4392+ 1.4394i	-141.45+ 141.47i			2.727- 1.192i	2.976	2.620- 1.000i	2.804
14	3	4756	13289	0.076196+ 0.000299i	-0.000828- 0.000393i	-3.7492+ 3.7497i	-50.31+ 50.32i	1.067+ 0.317i	1.113	1.917- 0.442i	1.967	1.960- 0.360i	1.993
	5			0.075217+ 0.000717i	-0.003675+ 0.002317i	-3.5793+ 3.5797i	62.36- 62.37i			0.917+ 0.550i	1.069	1.280+ 0.280i	1.310
	1			0.075834+ 0.000545i	0.002178- 0.002608i	1.6401+ 1.5030i	-148.66 136.23i			2.790- 1.168i	3.024	2.740- 0.900i	2.884
16	3	4753	17354	0.076342+ 0.000815i	0.000526+ 0.003535i	-3.8411+ 3.5208i	-33.39+ 30.60i	1.683- 0.083i	1.685	1.762- 0.275i	1.784	1.960- 0.300i	1.983
	5			0.076383+ 0.003033i	-0.000158+ 0.007133i	-3.1123+ 2.8522i	89.81- 82.31i			0.699+ 0.766i	1.037	1.000+ 0.440i	1.093
	1			0.073036+ 0.002377i	-0.017189+ 0.007064i	1.2395- 2.1911i	81.70- 144.42i			0.767+ 1.385i	1.583	0.880+ 1.180i	1.472
17	3	4677	16613	0.068103+ 0.004816i	-0.008021+ 0.005246i	2.3660- 4.1822i	9.38- 16.58i	1.400- 0.383i	1.451	1.342+ 0.318i	1.379	1.180+ 0.320i	1.223
	5			0.066183+ 0.006667i	-0.002125+ 0.004125i	1.6065- 2.8397i	-70.94 +125.40i			1.996- 0.915i	2.195	1.860- 0.520i	1.931
	1			0.076468i 0.002611i	0.002102+ 0.013137i	2.0237+ 1.5114i	178.11+ 133.02i			-0.063- 1.063i	1.065	0.180- 0.920i	0.937
19	3	4679	11913	0.076470+ 0.007304i	-0.001729+ 0.010446i	5.0161+ 3.7462i	72.16+ 53.89i	1.783+ 1.183i	2.140	0.849- 0.237i	0.881	0.780- 0.200i	0.805
	5			0.075375+ 0.011067i	-0.003383+ 0.008492i	5.1169+ 3.8215i	-61.58- 45.99i			2.010+ 0.723i	2.136	1.620+ 0.600i	1.728

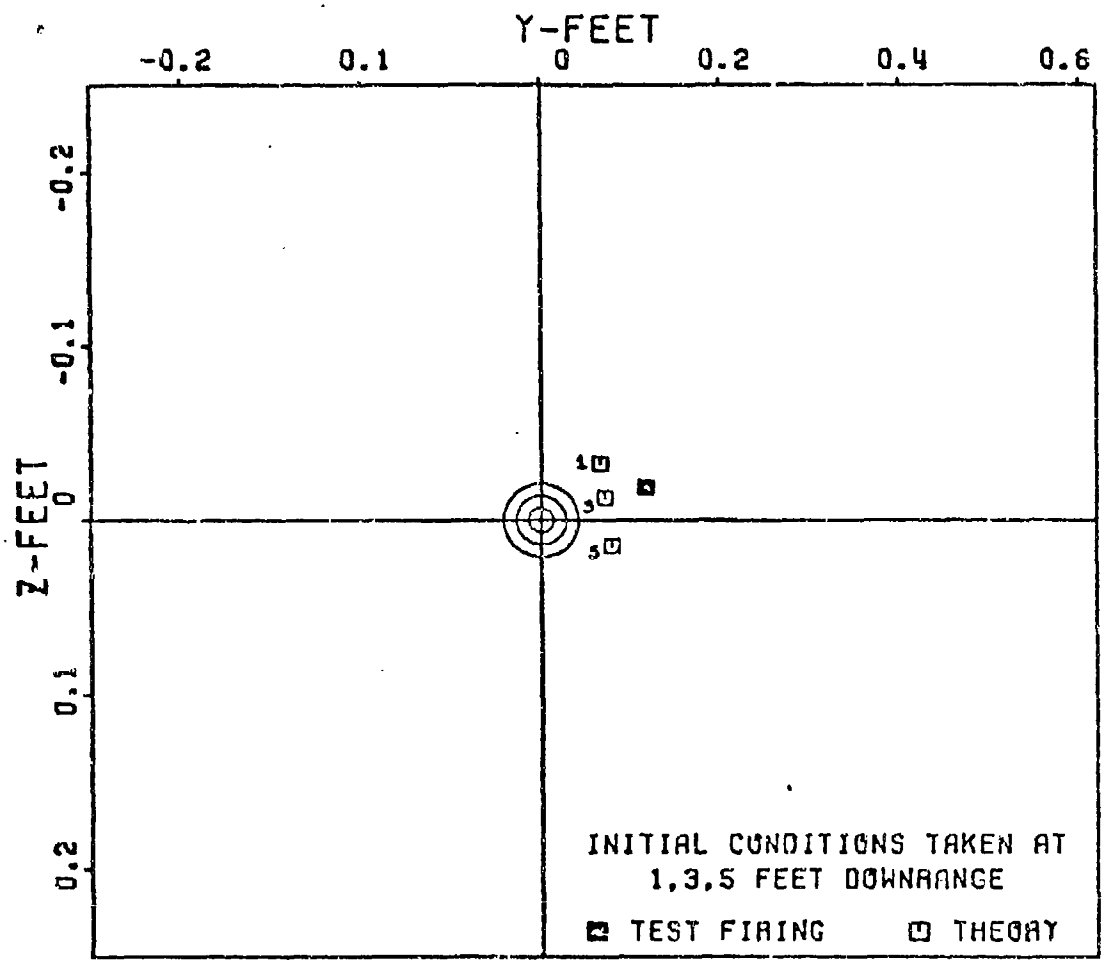


Figure 64. Dispersion: Ground Point - Round 4 Test Firing vs Theory, at 50 ft. Downrange

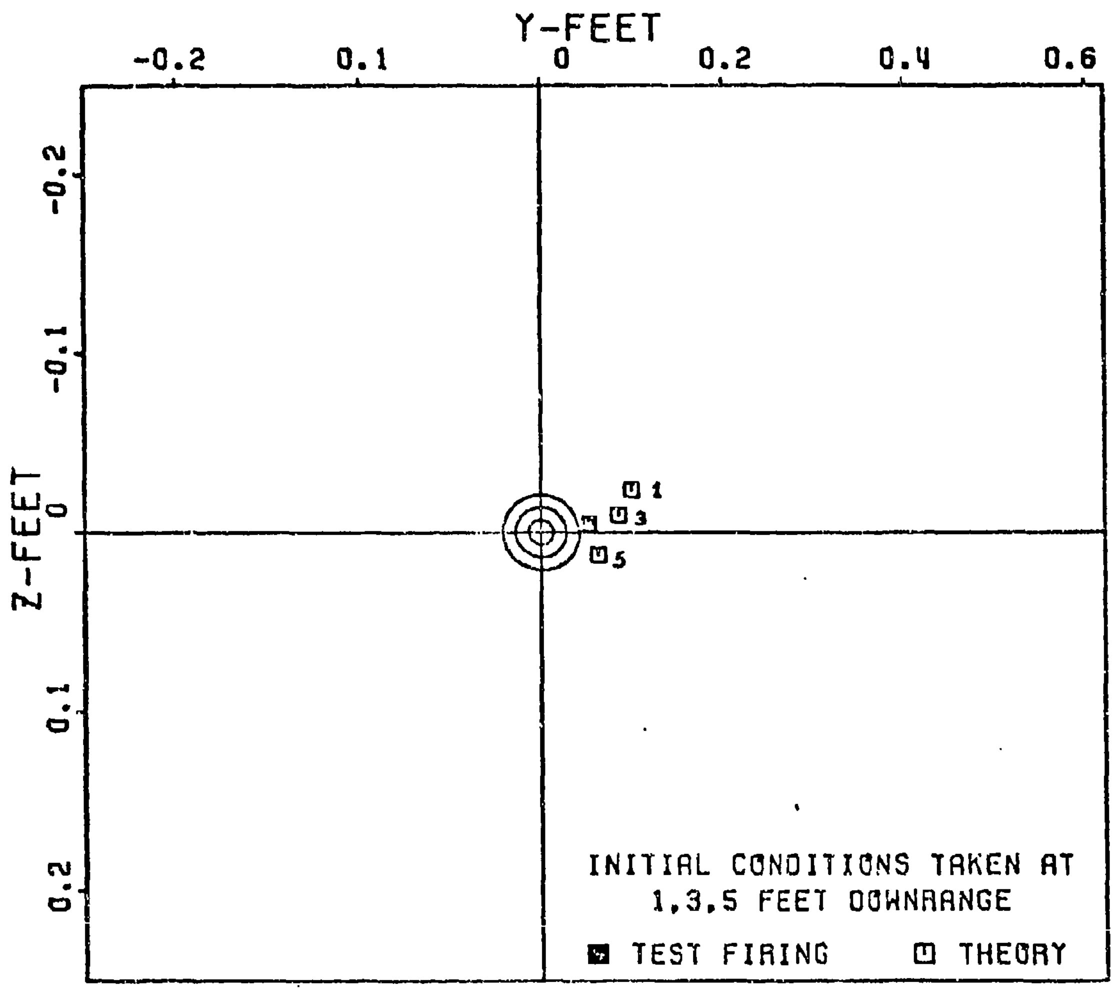


Figure 65. Dispersion: Ground Point - Round 6 Test Firing vs Theory, at 50 ft. Downrange

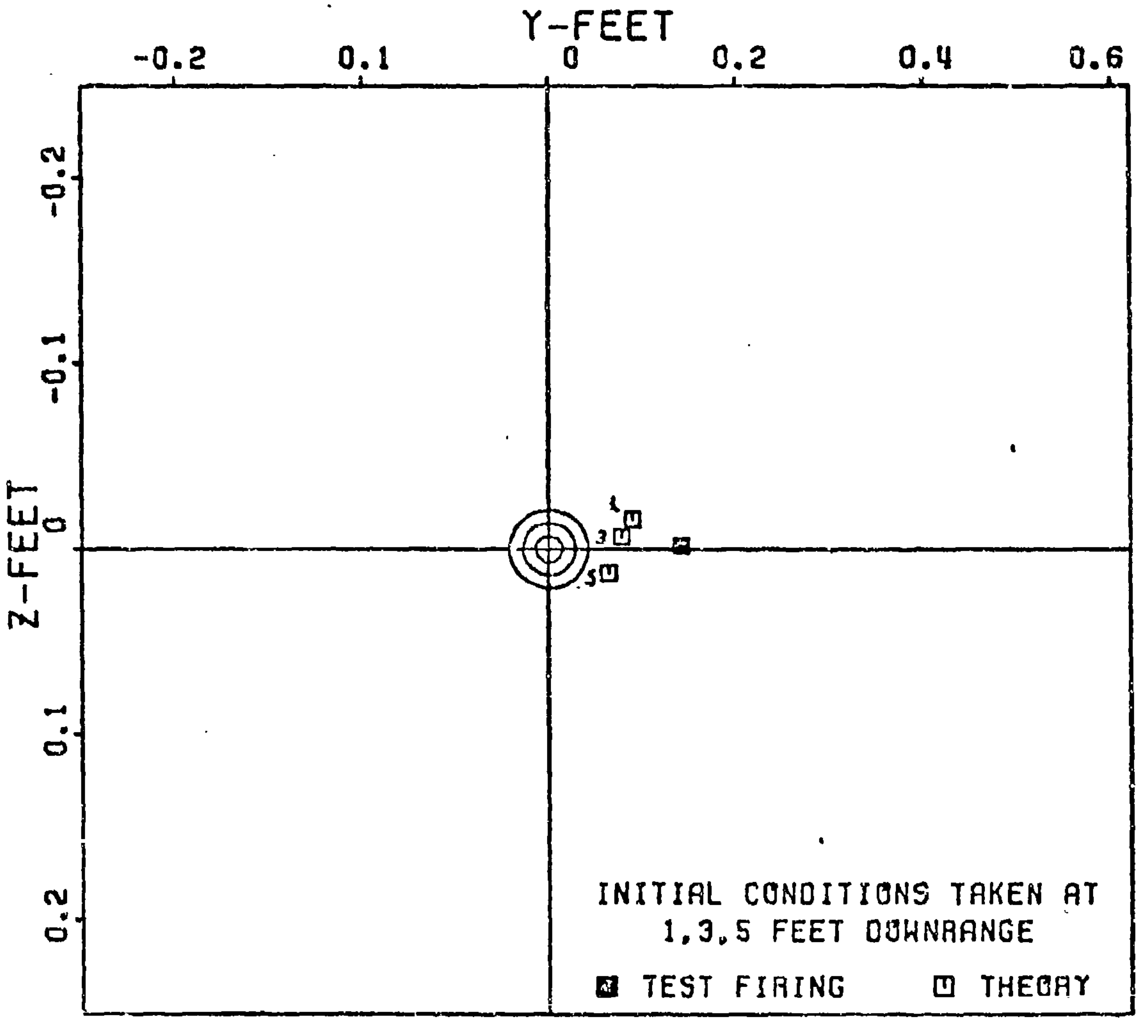


Figure 6?. Dispersion: Ground Point - Round 7 Test Firing vs Theory, at 50 ft. Downrange

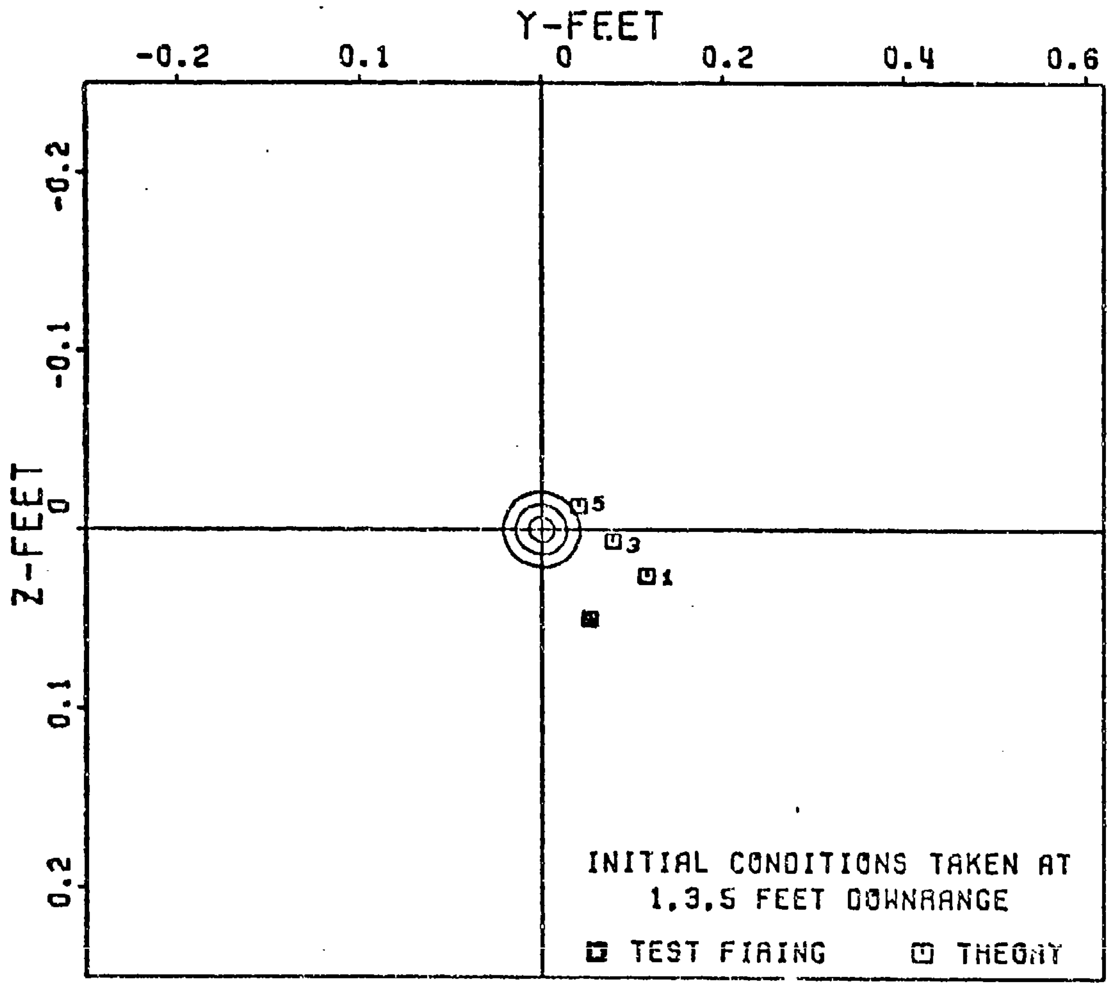


Figure 67. Dispersion: Ground Point - Round 8 Test Firing vs Theory, at 50 ft. Downrange

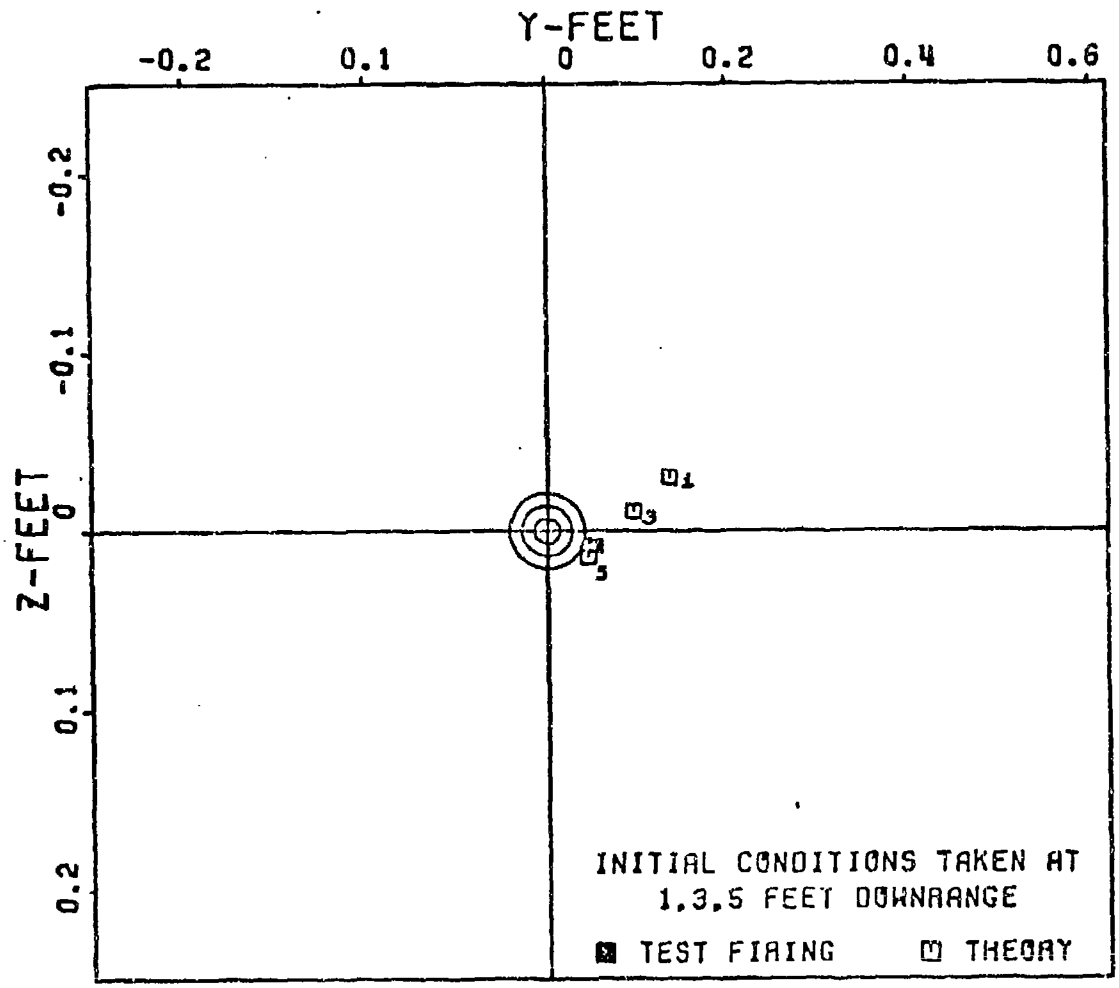


Figure 68. Dispersion: Ground Point - Round 14 Test Firing vs Theory, at 50 ft. Downrange

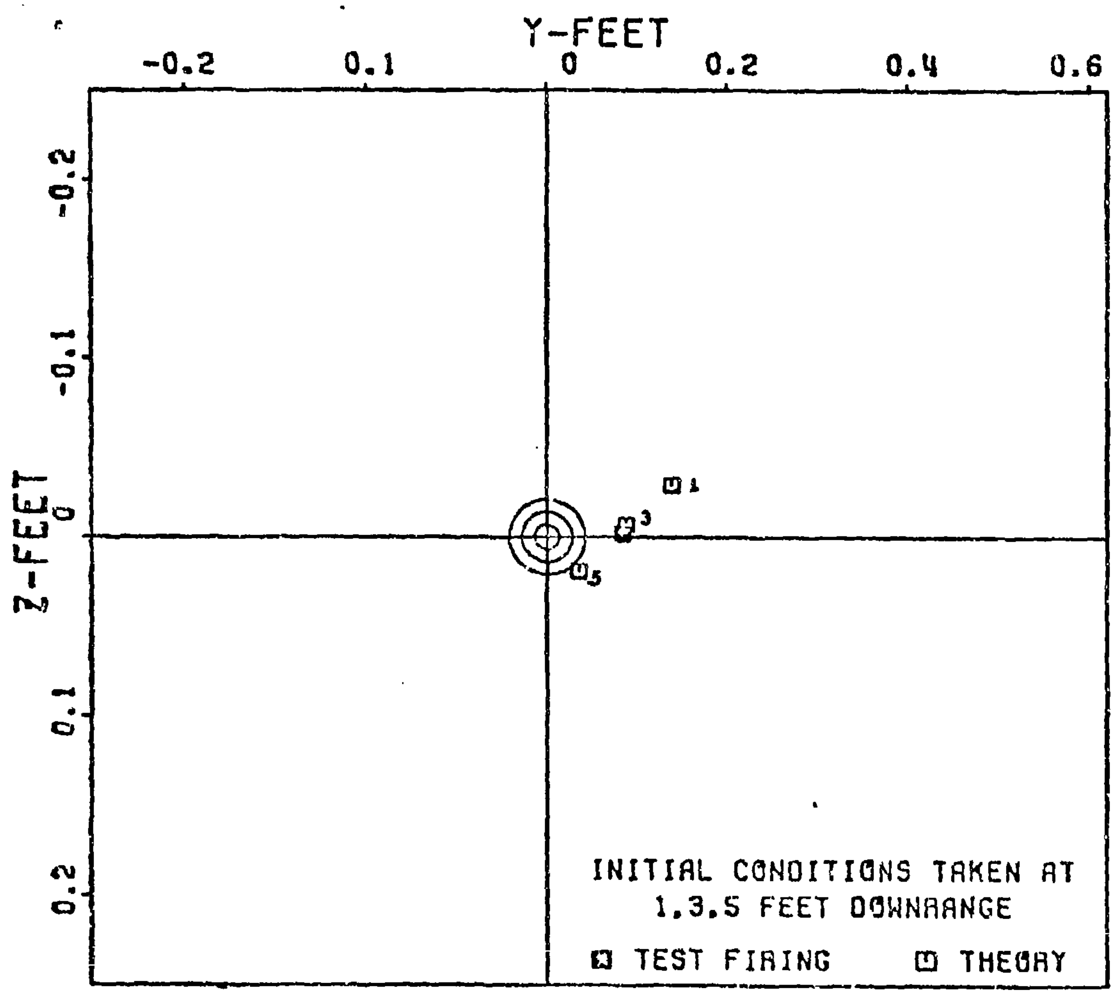


Figure 69. Dispersion: Ground Point - Round 16 Test Firing vs Theory, at 50 ft. Downrange

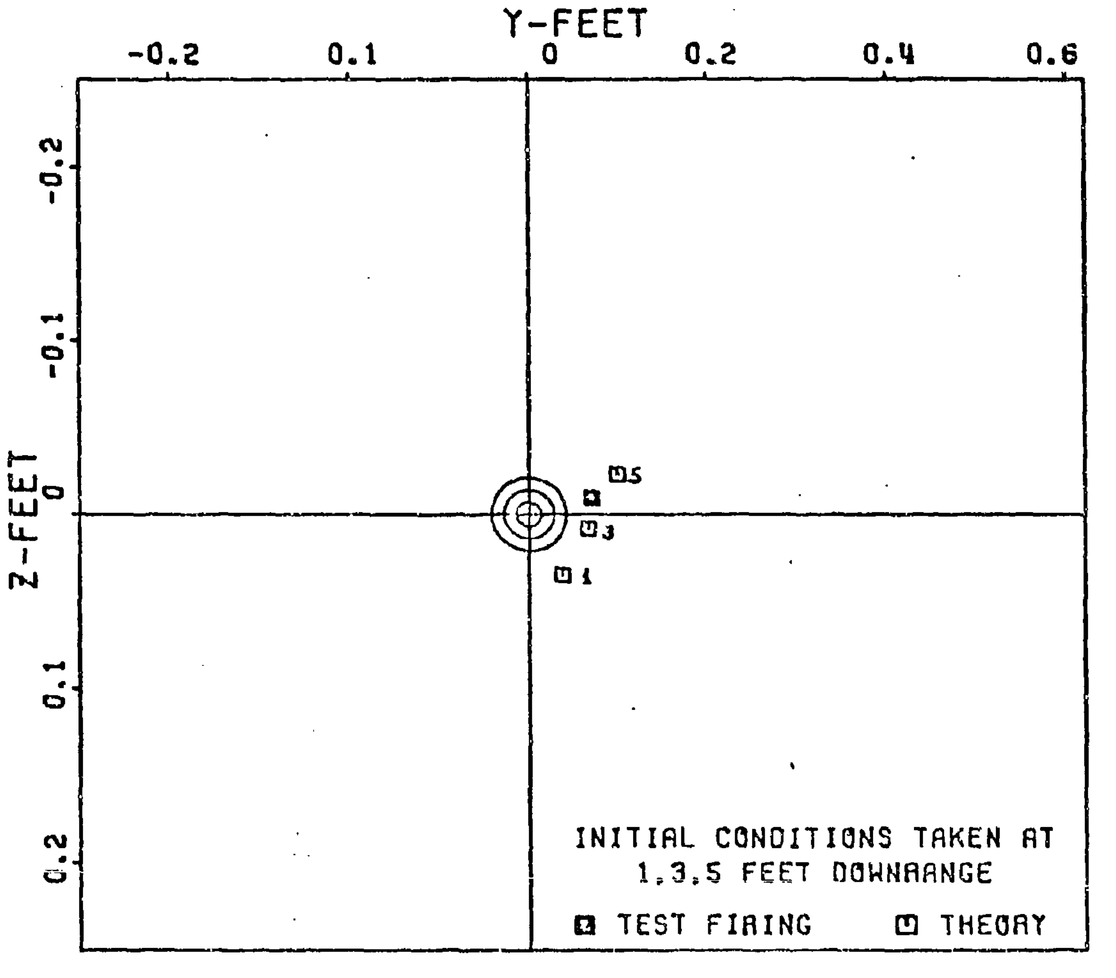


Figure 70. Dispersion: Ground Point - Round 17 Test Firing vs Theory, at 50 ft. Downrange

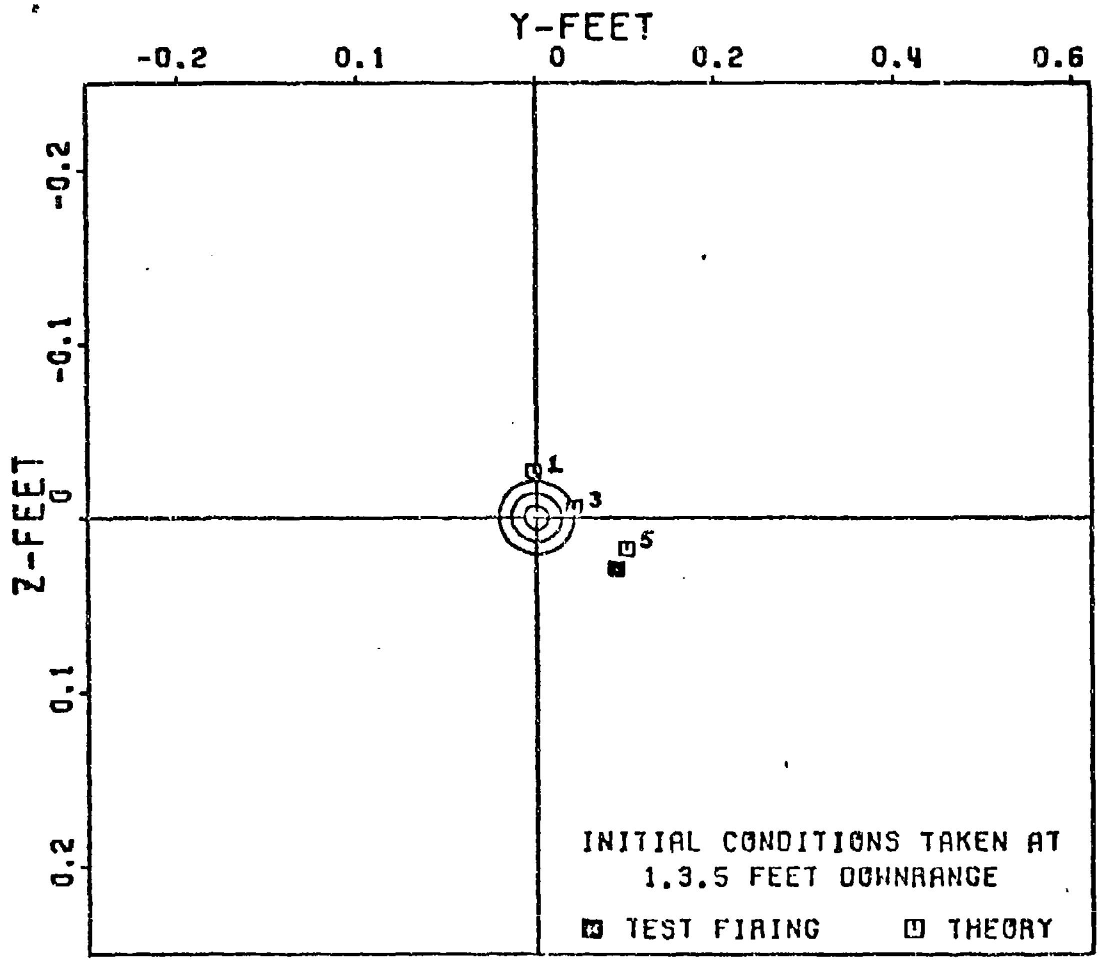


Figure 71. Dispersion: Ground Point - Round 19 Test Firing vs Theory, at 50 ft. Downrange

that the initial conditions would occur immediately after leaving the gun barrel. However, the flechette being a finned body needs a sabot configuration to guide it down the barrel, Figure 29. The sabot causes the initial condition location problem since the sabot must separate from the flechette outside of the gun barrel. The exact time and place where this occurs is not constant; varying from round to round. Not only does the sabot separate from the flechette instantaneously different every time, the sabot may not separate cleanly or the same way every time. Interference with the fins after sabot separation can cause disturbances to the flechette and alter the initial conditions. In addition, asymmetric sabot separation can influence the initial conditions. Figures 72-79 illustrate the flight transition sequence for the 8 flechette test rounds. In every sequence the sabot begins to separate, in varying degrees, 1 ft. downrange. At 3 ft. downrange, the sabot is nearly completely separated, but in some cases the sabot particles pose interference problems with the fins. By 5 and 7 ft. downrange the sabot has completely separated and the flechette is in free flight. The correspondence between the flight transition sequence and dispersion results can be seen in each individual round. Figure 64 indicates that the initial conditions for round 4 occur somewhere between 1 and 3 ft. downrange judging by the dispersion of the actual tested round. Figure 72 verifies this fact in that the sabot has separated from the flechette between 1 and 3 ft. downrange. The y-coordinate in the dispersion vector does not

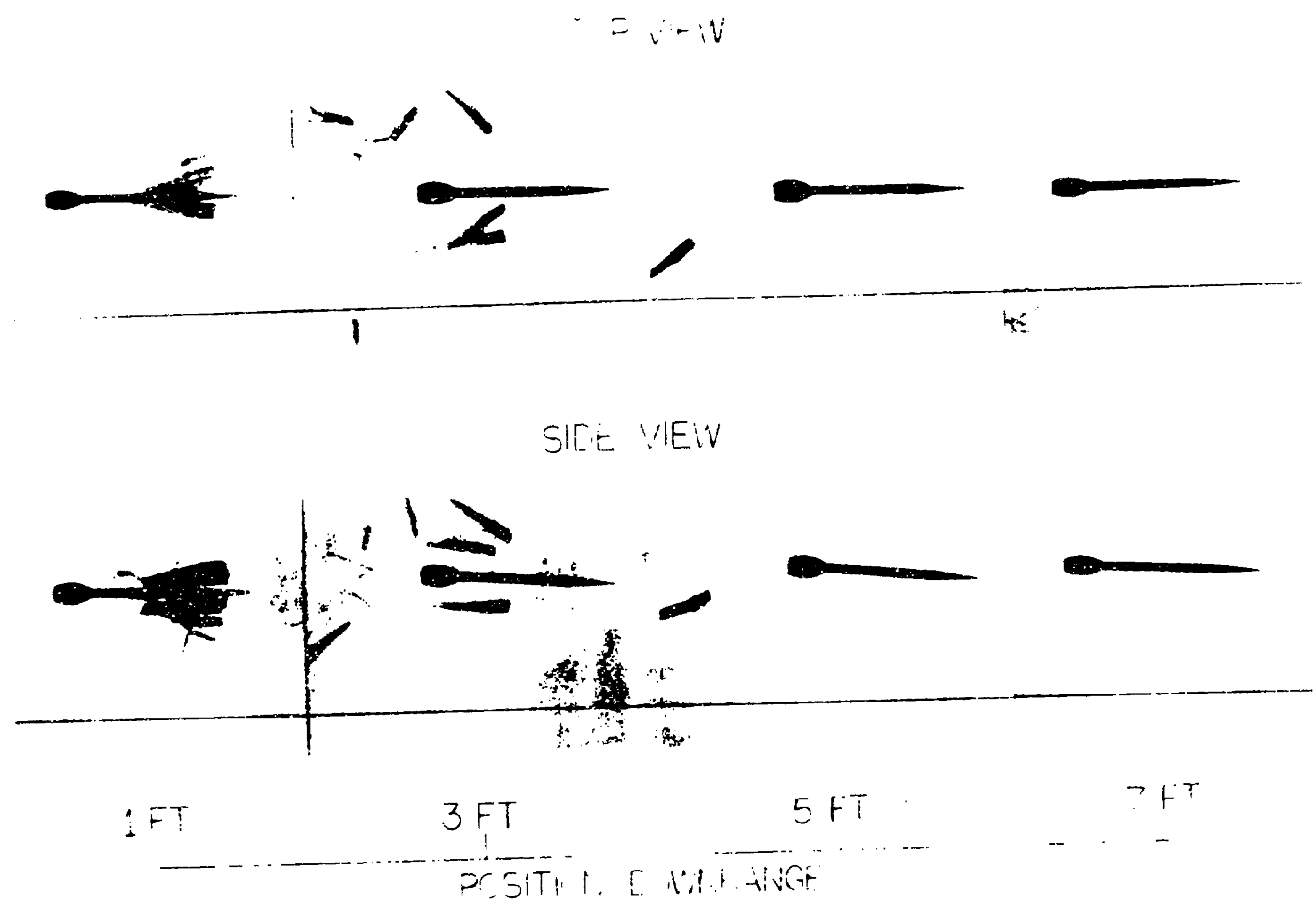


Figure 72. Flight Transition Sequence - Round 4

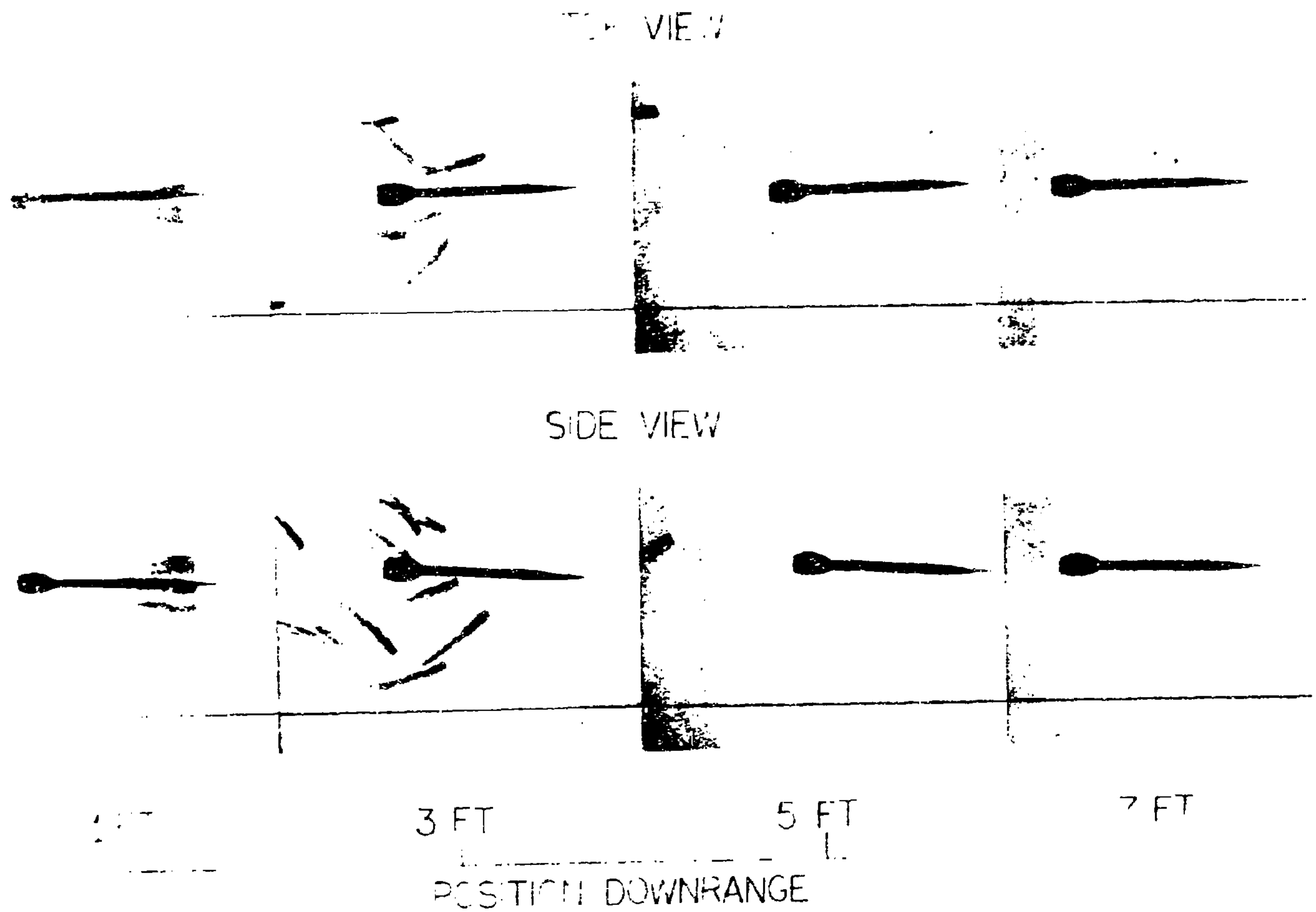


Figure 73. Flight Transition Sequence - Round 6

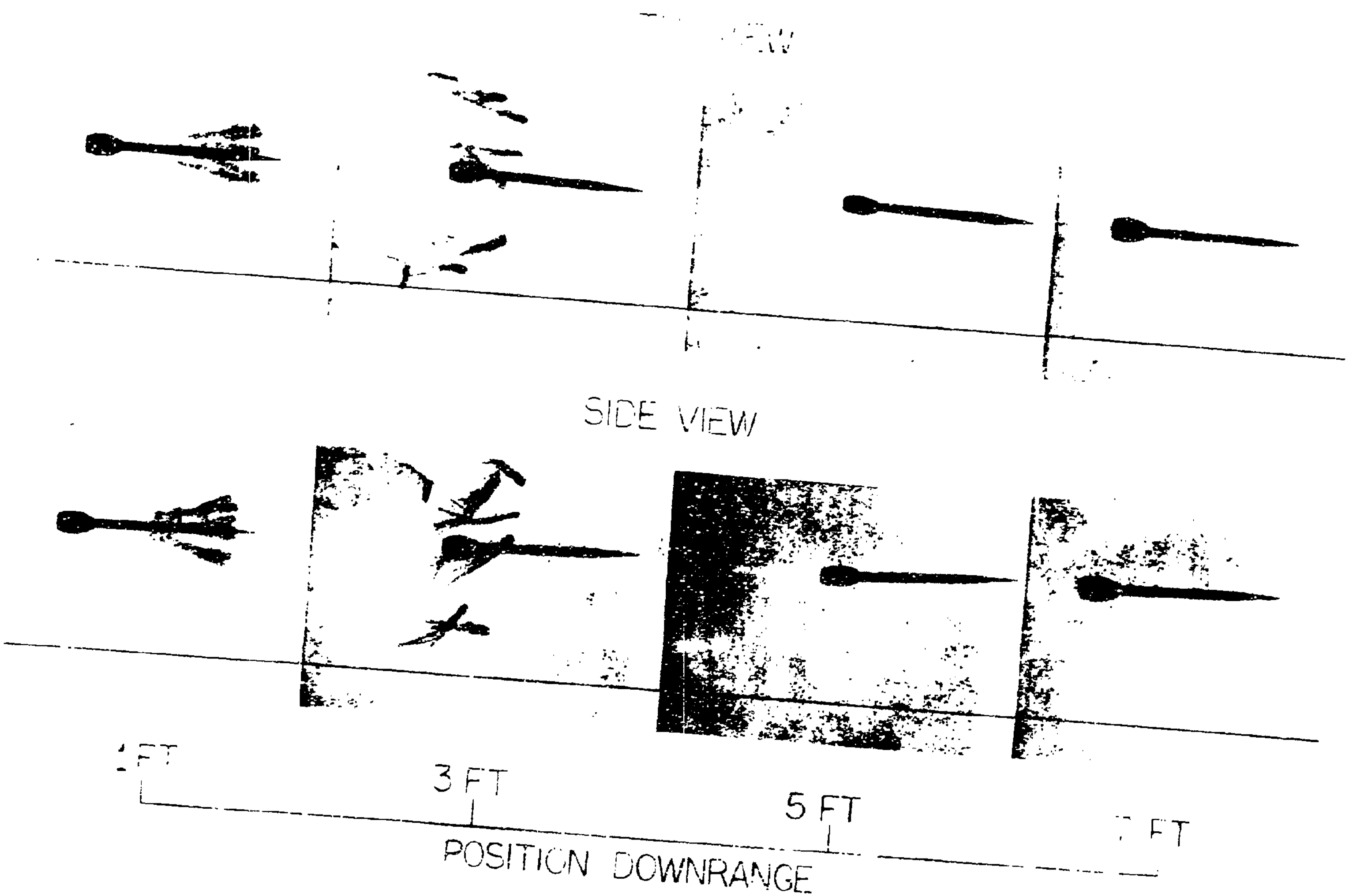


Figure 74. Flight Transition Sequence - Round 7

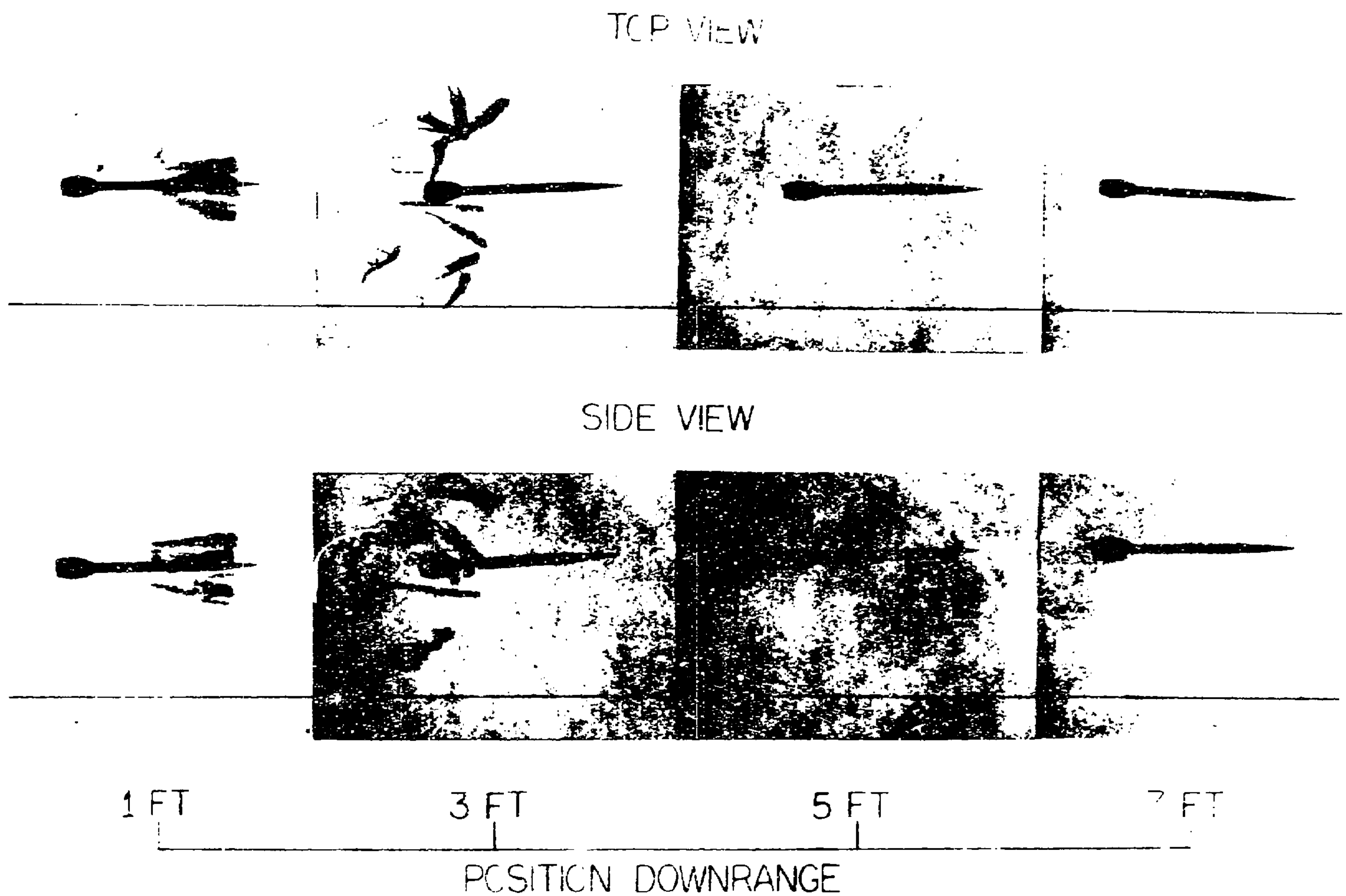


Figure 75. Flight Transition Sequence - Round 8

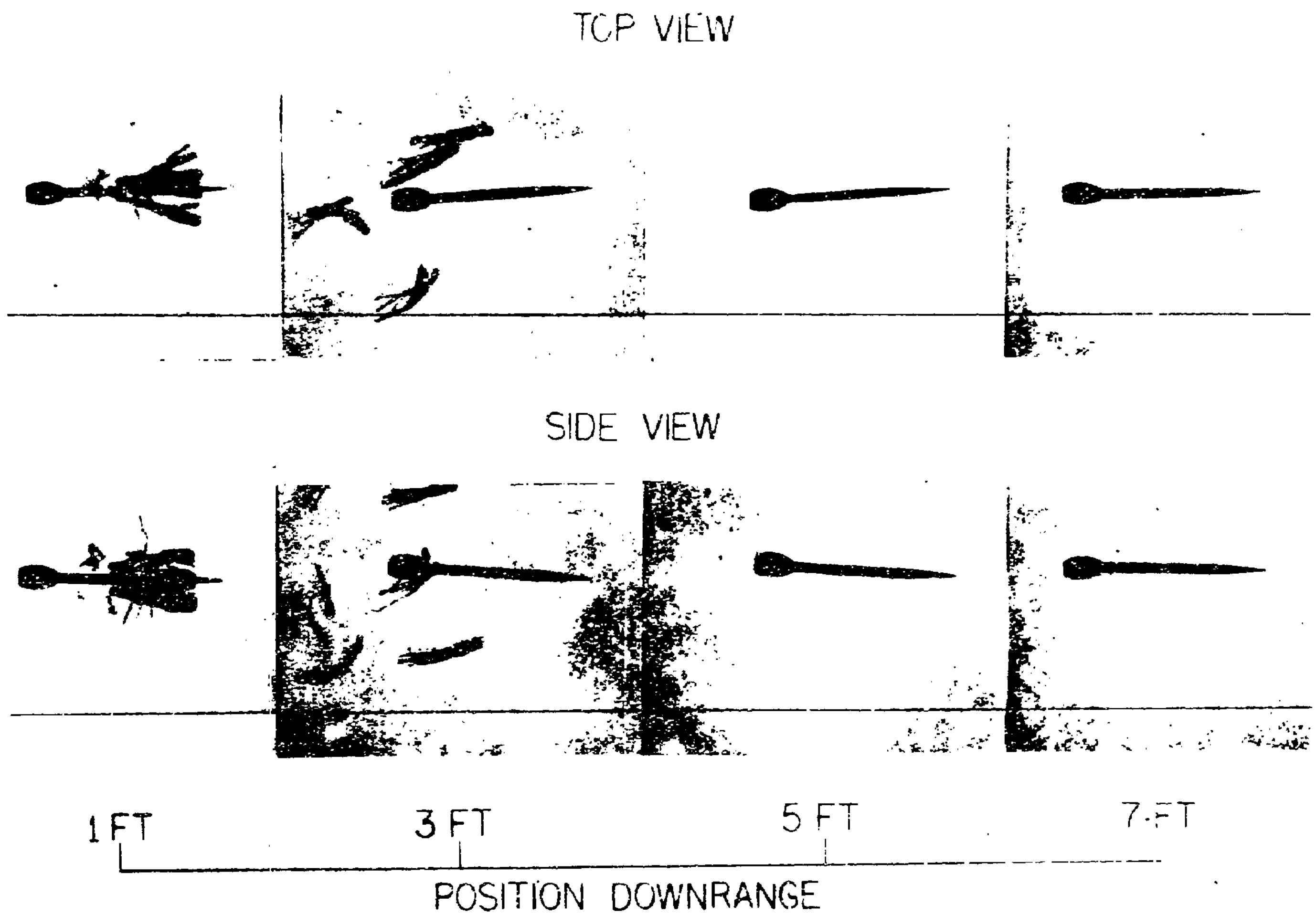


Figure 76. Flight Transition Sequence - Round 14

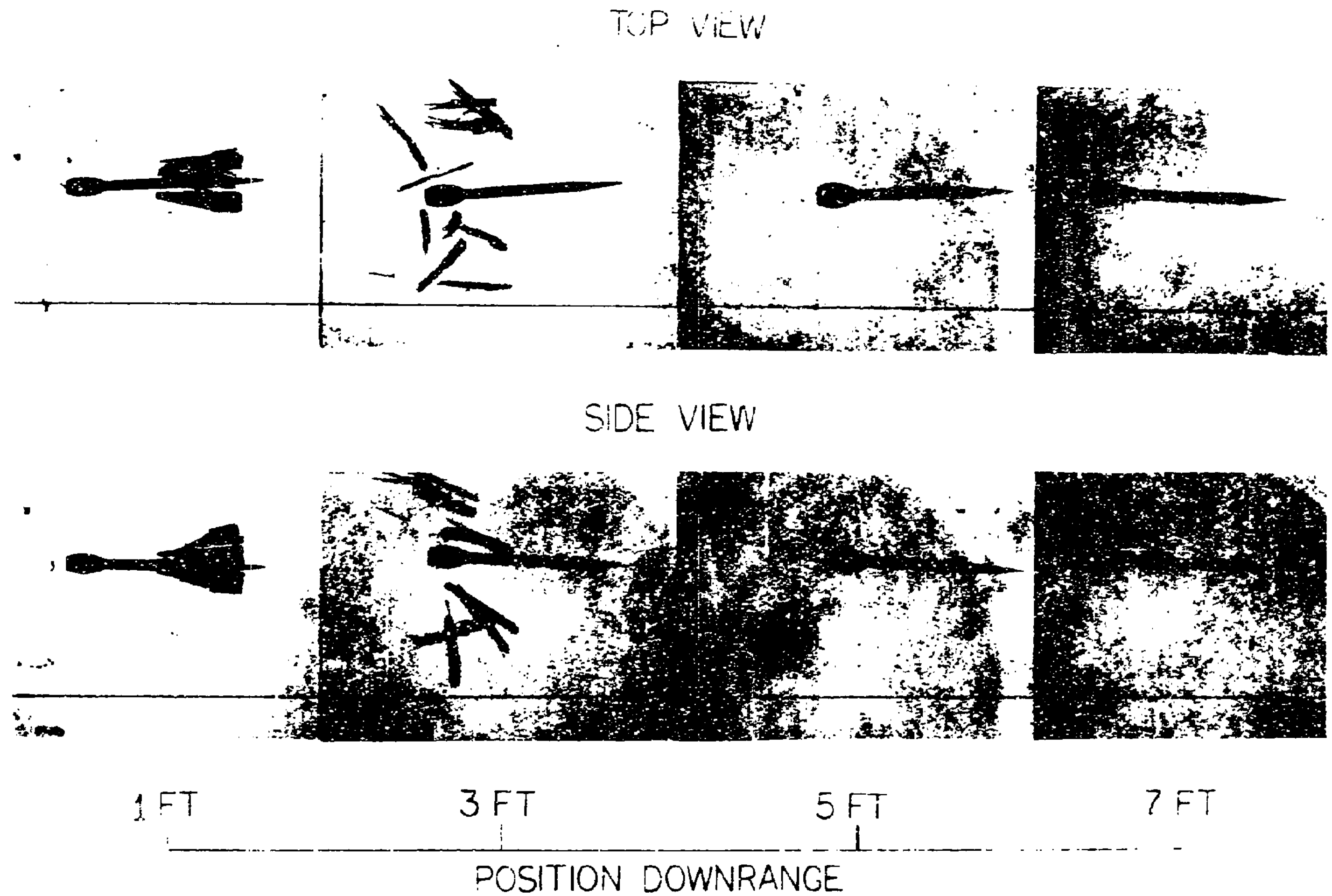


Figure 77. Flight Transition Sequence - Round 16

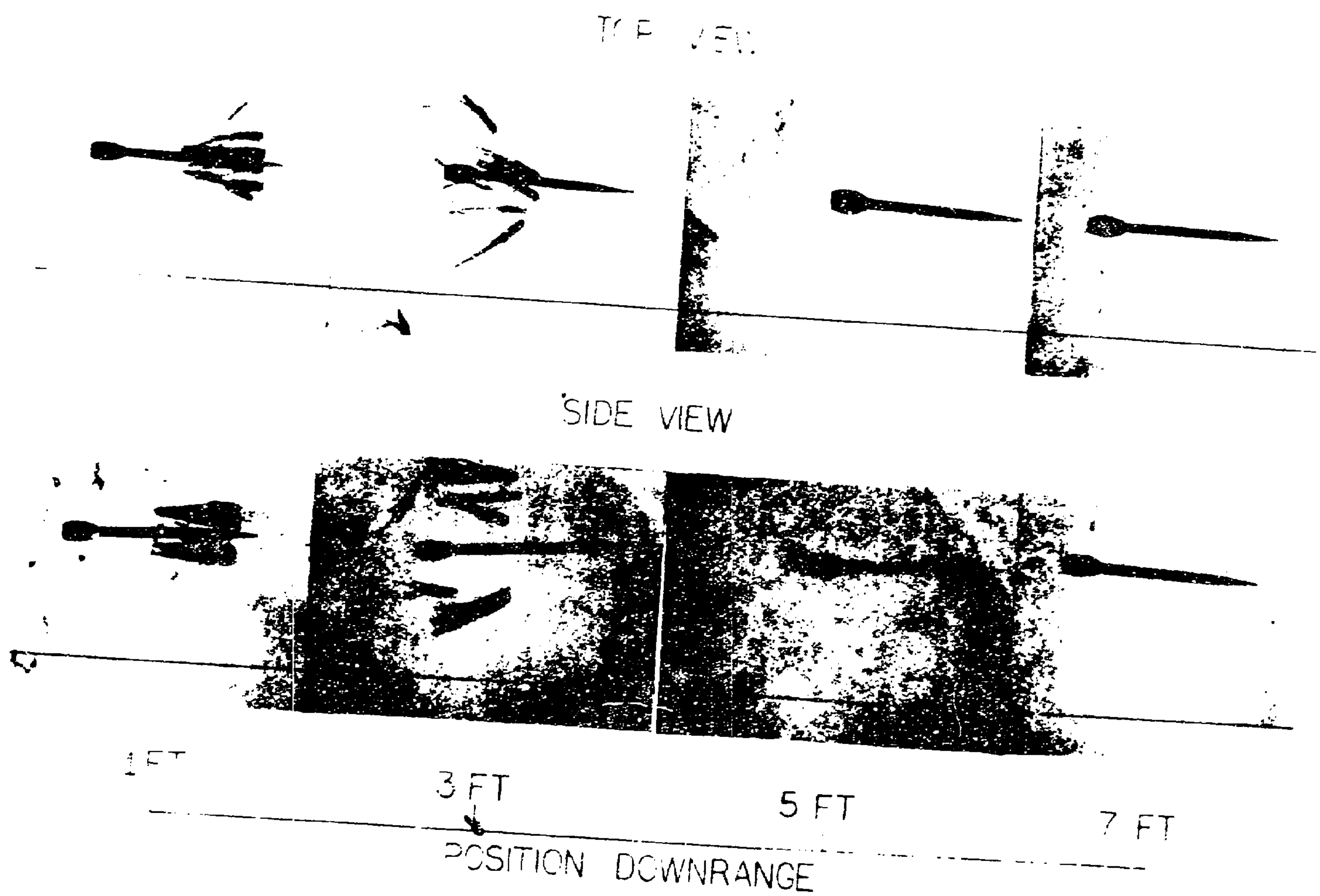


Figure 78. Flight Transition Sequence - Round 17

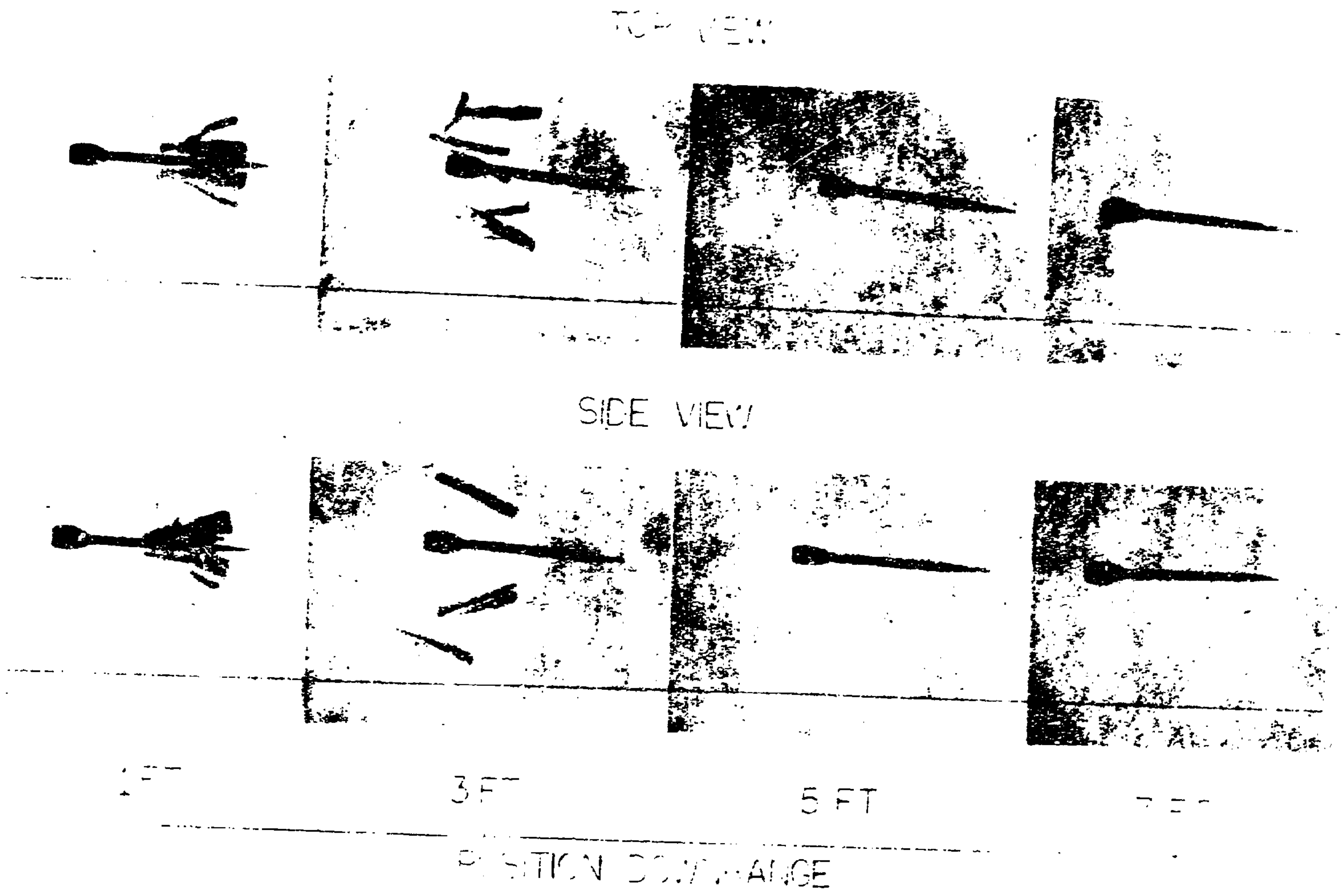


Figure 79. Flight Transition Sequence - Round 19

accurately agree with the theory for this case. However, besides computational error other physical factors can influence dispersion. Contributions by fin asymmetries and other configurational asymmetries can be important but are unable to be detected or accounted for. Throughout this analysis this must be kept in mind to partially account for any discrepancy between the actual test firing and the theory and 6-D computations. Figure 65 indicates the initial conditions for round 6 occur between 3 and 5 ft. downrange. Figure 73 verifies this choice showing separation occurring around 3 ft but with sabot particles very close to the fins causing possible interference and delaying the initial conditions location. The initial conditions location for round 7 is difficult to accurately choose since the y-coordinate does not accurately agree, Figure 66. It is safe to say that the initial conditions occur sometime around 3 ft and Figure 74 verifies this choice. The z-coordinate for round 8 is not as accurate as would be desired, Figure 7, but the y-coordinate indicates initial conditions occurring between 3 and 5 ft downrange. Figure 75 agrees with this choice indicated interference with the fins at 3 ft delaying the initial conditions. Initial conditions for round 14 are chosen between 3 and 5 ft. downrange, Figure 68. Figure 76 indicates possible fin interference tending to verify the choice. Figures 69 and 77 indicate and verify the choice of initial conditions in the immediate vicinity of 3 ft downrange for round 16. Possible fin interference at 3 ft downrange, Figure 78, round 17, verifies a choice of initial conditions between 3 and 5 ft, Figure 70. A similar situation occurs for round 19 in Figures 71 and 79. It is often difficult to choose initial condition positions accurately due to slight discrepancies between theory and test firings. However, the discrepancies are of the order 0.05 ft, which shows up large in Figures 64-71 due to the scale chosen, but is within the error expected from the validation of theory section.

The influence of sabot separation can be readily seen by inspection of Figures 72-79, 1 and 3 ft downrange. In every case, the flechette and sabot are at nearly a zero angle of attack at 1 ft, but has changed angle of attack noticeably by 3 ft downrange. This would indicate that fin interference or asymmetric sabot separation is causing the noticeable effect. It can be concluded that dispersion is dependent upon the initial conditions that the initial conditions are a function of sabot separation and that the theory can predict what the initial conditions are and where they occur.

Dispersion Theory vs. First Maximum Yaw Hypothesis

A popular theory to predict the dispersion of flechettes is the First Maximum Yaw Hypothesis. This theory relates the dispersion magnitude to the first maximum yaw magnitude by a nearly linear relationship. Other initial conditions such as angular rate, $\vec{\dot{\alpha}}_0$ and translational velocity, $\vec{\dot{S}}_0$ are said not to effect dispersion. To disprove this theory and strengthen the position of the theory ascribing to dispersion due to initial conditions $\vec{\dot{S}}_0$, $\vec{\alpha}_0$, $\vec{\dot{\alpha}}_0$, the First Maximum Yaw theory was applied to Frankford Arsenal data. Figure 80 shows a plot of dispersion magnitude vs. first maximum yaw magnitude. Clearly no linear relationship exists between

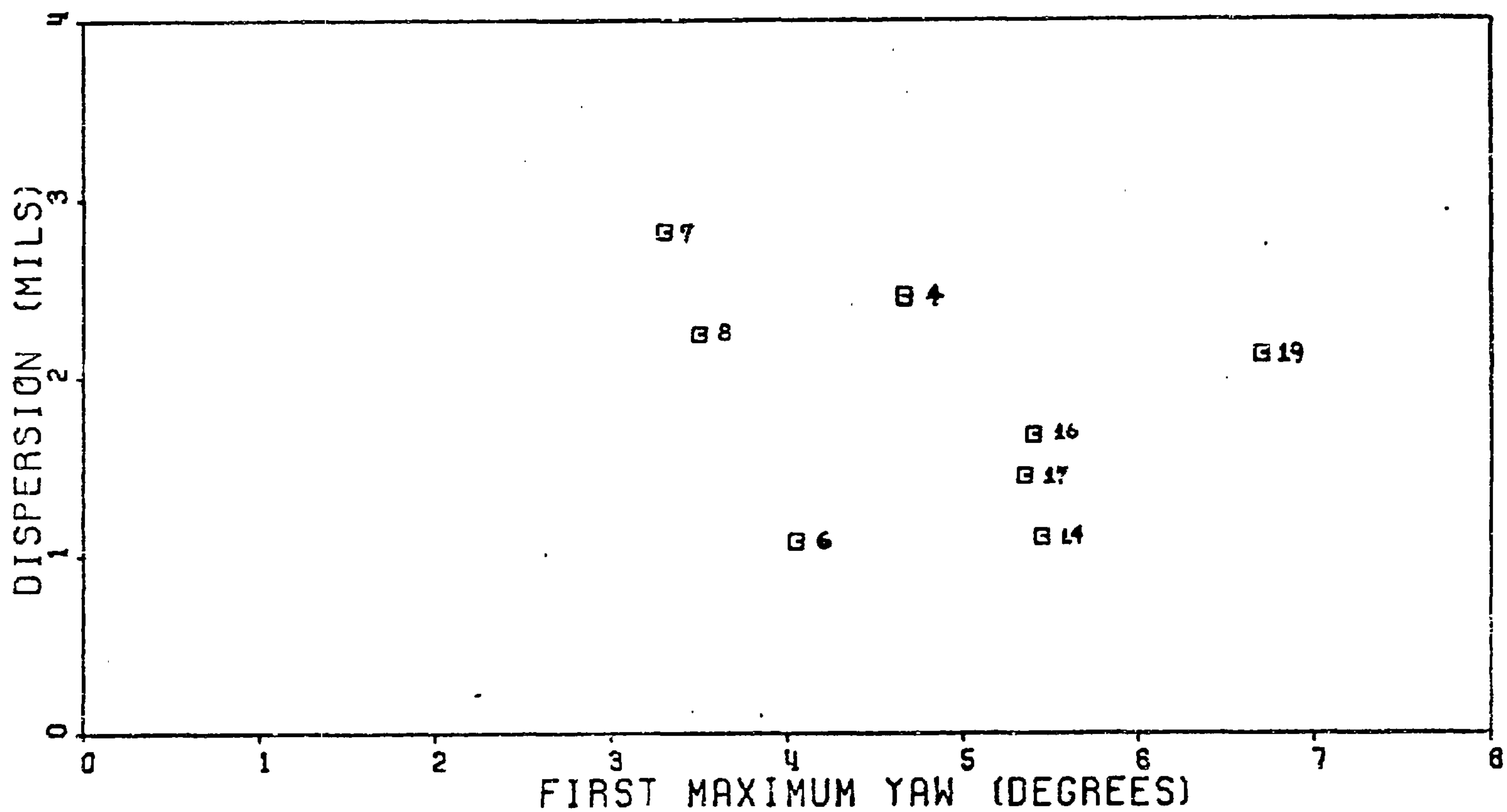


Figure 80. Dispersion vs First Maximum Yaw, Frankford Test Firing Results

dispersion and first maximum yaw. In fact, the plotted data resembles a random shotgun blast. Figures 81,82 and 83 employ the theory to the first maximum yaw hypothesis. Again the plot substantiates the findings of Figure 80. The disproval of the first maximum yaw hypothesis comes as no surprise since the dispersion theory contradicts it and the 6-D computations, which integrate the actual equations of motion, validated the dispersion theory. Therefore, dispersion could never accurately be predicted by a theory involving only first maximum yaw.

The influence of initial conditions, $\vec{\dot{S}}_o$, $\vec{\alpha}_o$, and $\vec{\dot{\alpha}}_o$ and dispersion for the actual test firings are expected to be different from that in the validation of theory section because of the different ranges in the initial conditions. For example, $\vec{\dot{S}}_o$ in the validation section was (100 + 100i) ft/sec. In the actual test firings, $\vec{\dot{S}}_o$ only ranged as high as 0.017 ft/sec. Of course, the large value was only to validate the theory. Here $\vec{\dot{S}}_o$ is very small and its contribution is accordingly smaller. In the reduced equation 24, employed to calculate the theory column in Table XXII,

$$\overrightarrow{J.A.}\,(\text{mils}) = 1000\left[\frac{\vec{S}_o}{x} + \frac{\vec{\dot{S}}_o}{u} - \frac{I_y}{mud}\,A\left(\vec{\dot{\alpha}}_o - \vec{\alpha}_o\,\frac{ipI_x}{I_y}\right)\right]$$

for round 4, 1 ft downrange,

$$1000\,\frac{\vec{\dot{S}}_o}{u} = (0.001562 + 0.001841i)\ \text{mils}$$

where as,

$$\overrightarrow{J.A.} = (1.329 - 1.302i)\ \text{mils}$$

Since this is typical of the 8 rounds tested, $\vec{\dot{S}}_o$ has little effect on dispersion for these rounds.

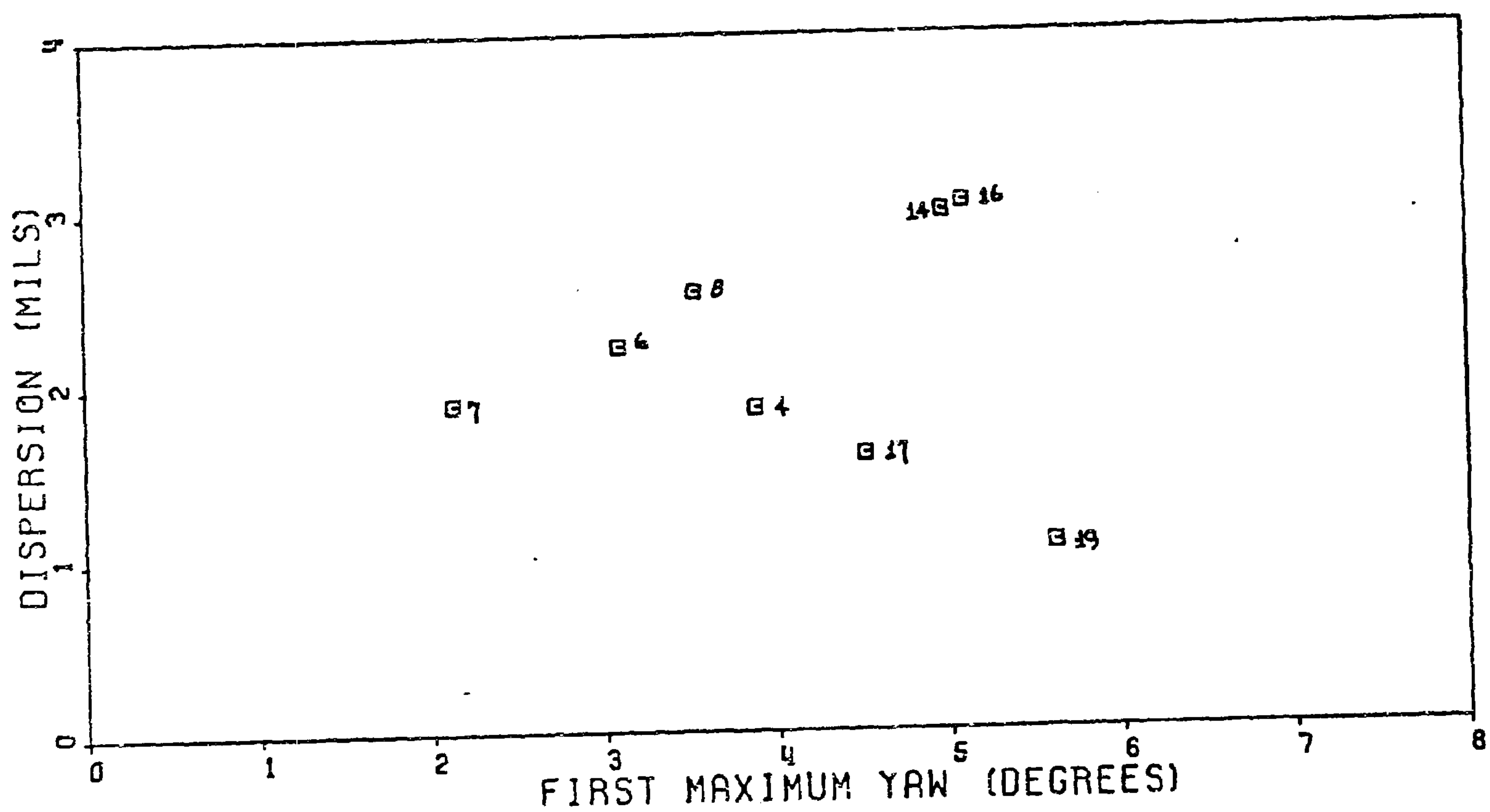


Figure 81. Dispersion vs First Maximum Yaw, Theory - Initial Conditions, 1 ft Downrange

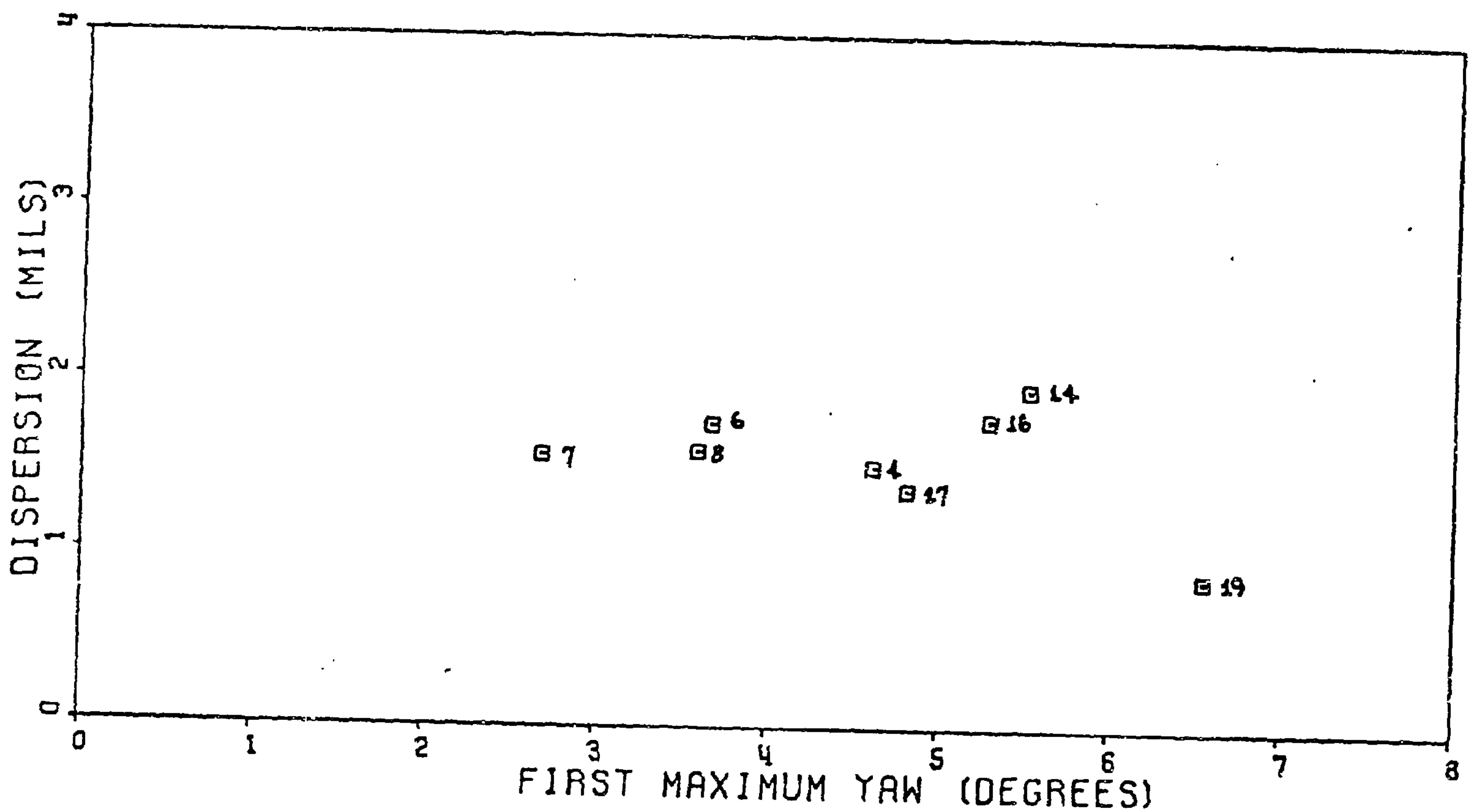


Figure 82. Dispersion vs First Maximum Yaw, Theory - Initial Conditions, 3 ft. Downrange

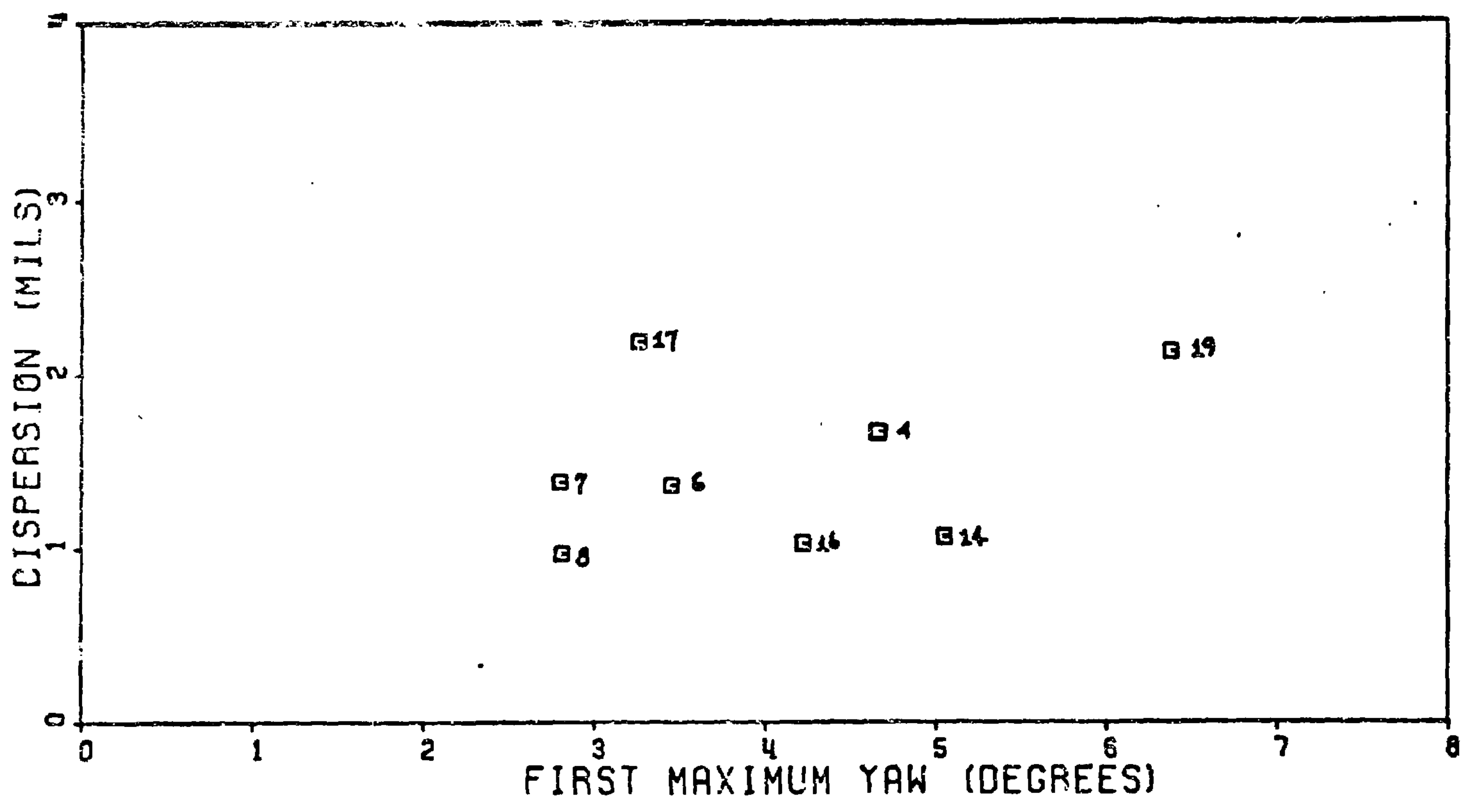


Figure 83. Dispersion vs First Maximum Yaw, Theory - Initial Conditions, 5 ft. Downrange

Similarly, for this particular case,

$$1000 \frac{\vec{S}_o}{x} = (1.519360 + 0.041760i) \text{ mils}$$

$$1000 \vec{\alpha}_o \frac{ipI_x A}{mud} = (-0.01437 + 0.00214i) \text{ mils}$$

$$-1000 \vec{\dot{\alpha}}_o \frac{I_y A}{mud} = (-0.206075 - 1.383672i) \text{ mils}$$

Obviously, $\vec{S}_o$ and $\vec{\dot{\alpha}}_o$ are by far the greatest contributors to dispersion for this case. Inspection of all the other 23 cases in Table XXII agrees with this general pattern. $\vec{S}_o$ can be nearly eliminated, of course, by accurate setup of the test equipment so that the gun barrel is set exactly at coordinates (0,0). Any $\vec{S}_o$ then would occur from displacement due to the blast. This leaves the major culprit in dispersion to be $\vec{\dot{\alpha}}_o$. Figure 84 illustrates the dependence of the Jump Angle, and hence dispersion, upon angular rate and angle of attack.

Although $\vec{\dot{\alpha}}_o$ contributes the most to the Jump Angle, the combination of $\vec{\dot{S}}_o$ and $\vec{\alpha}_o$ also has a noticeable influence. From the test firings, $\vec{\dot{S}}_o$ was found to have a negligible effect on dispersion. Therefore, it is neglected in Figure 84 to simplify the plot. It is evident from Figure 84 that various combinations of $\vec{\alpha}_o$ and $\vec{\dot{\alpha}}_o$ yield zero dispersion. It is possible that large values of $\vec{\alpha}_o$ and $\vec{\dot{\alpha}}_o$ can combine to yield zero dispersion; an impossibility with the first maximum yaw hypothesis. If α_o and $\dot{\alpha}_o$ are able to balance to give zero dispersion, then this idea can be expanded to include the entire equation.

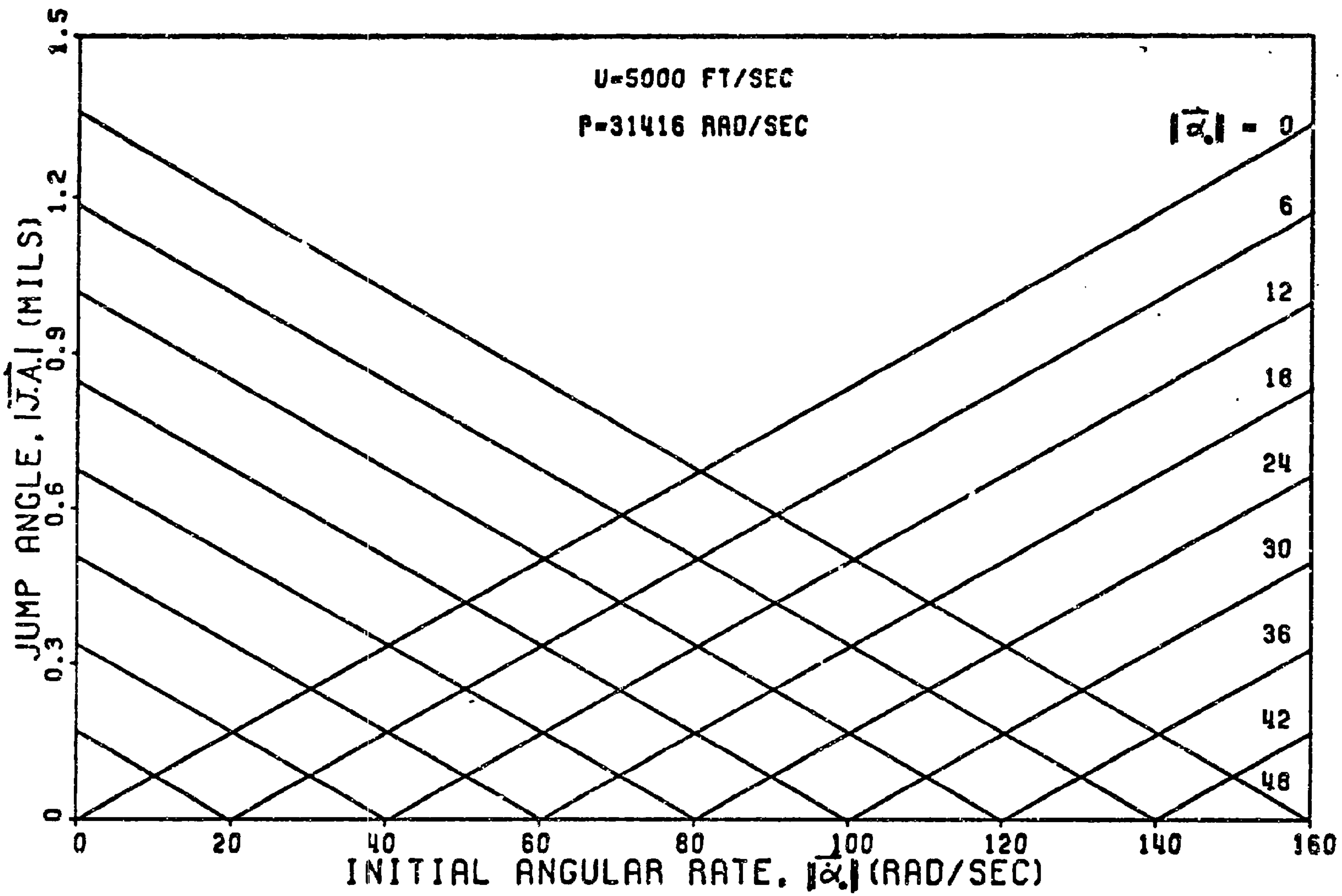


Figure 34. Jump Angles for Various Initial Conditions

The governing equation used throughout this dispersion analysis section is:

$$\overrightarrow{J.A.} = 1000\left[\frac{\vec{S}_o}{x} + \frac{\dot{\vec{S}}_o}{u} - \frac{I_y}{mud} A\left(\dot{\vec{\alpha}}_o - \vec{\alpha}_o \frac{ipI_x}{I_y}\right) + \frac{ig}{2}\left(\frac{x}{u^2}\right)\right]$$

Eliminating the constant gravity term,

$$\overrightarrow{J.A.} = 1000\left[\frac{\vec{S}_o}{x} + \frac{\dot{\vec{S}}_o}{u} - \frac{I_y}{mud} A\left(\dot{\vec{\alpha}}_o - \vec{\alpha}_o \frac{ipI_x}{I_y}\right)\right]$$

Setting $\overrightarrow{J.A.}$ to zero, the idea benind Figure 84 is expanded to include $\vec{S}_o$, $\dot{\vec{S}}_o$.

$$\frac{\vec{S}_o}{x} + \frac{\dot{\vec{S}}_o}{u} = \frac{I_y}{mud} A\left(\dot{\vec{\alpha}}_o - \vec{\alpha}_o \frac{ipI_x}{I_y}\right)$$

rearranging

$$m\left[\vec{S}_o\left(\frac{u}{x}\right) + \dot{\vec{S}}_o\right] = \frac{A}{d}\left(\dot{\vec{\alpha}}_o I_y - \vec{\alpha}_o ipI_x\right)$$

A dimensional analysis of the equations finds that both sides have units of momentum or impulse. Going one step farther it can be said that to obtain zero dispersion:

initial transverse momentum = initial angular momentum

Therefore it is the imbalance in the initial momentums that causes dispersion. The size of initial conditions can be huge, Figure 84, but if they can combine to balance, zero dispersion results. The way the initial conditions combine, determine the magnitude of the imbalance or dispersion. It should be noted that this dispersion discussed is round to round dispersion and that the inconsistency of the momentum imbalance from round to round causes a dispersion pattern (a set of rounds). The next section will highlight this principle in the evaluation of physical factors affecting dispersion.

PHYSICAL EVALUATION OF DISPERSION

Initial momentum imbalance has been shown to cause dispersion. Initial conditions determine the magnitude of the imbalance. What causes these initial conditions to occur is the subject of this final section. Initial conditions occur somewhere between zero and five feet downrange to different degrees of magnitude due to various conditions. These conditions are:

1. Fin or body asymmetry
2. In-bore mal-alignment
3. Asymmetric blast
4. Asymmetric sabot separation
5. Sabot-fin interference
6. Fin or body damage

Fin or body asymmetries can cause dispersion magnitudes to range as much or greater than those in the Validation of Theory section for aerodynamic asymmetries. These asymmetries can be overcanted or bent fins, damaged nose cone, or even body deformities. Figure 85 which shows in-bore mal-alignment also shows a slightly bent body, concave downward. In-bore mal-alignment can be attributed to warping and/or the entire flechette at some angle of attack. Clearly, if this flechette were fired, the in-bore angle of attack would produce an $\vec{\alpha}_o$ outside the gun barrel even before sabot separation. With the flechette at some angle of attack, the blast can cause a large $\vec{\dot{\alpha}}_o$ and an $\vec{S}_o$ and $\vec{\dot{S}}_o$. The blast itself

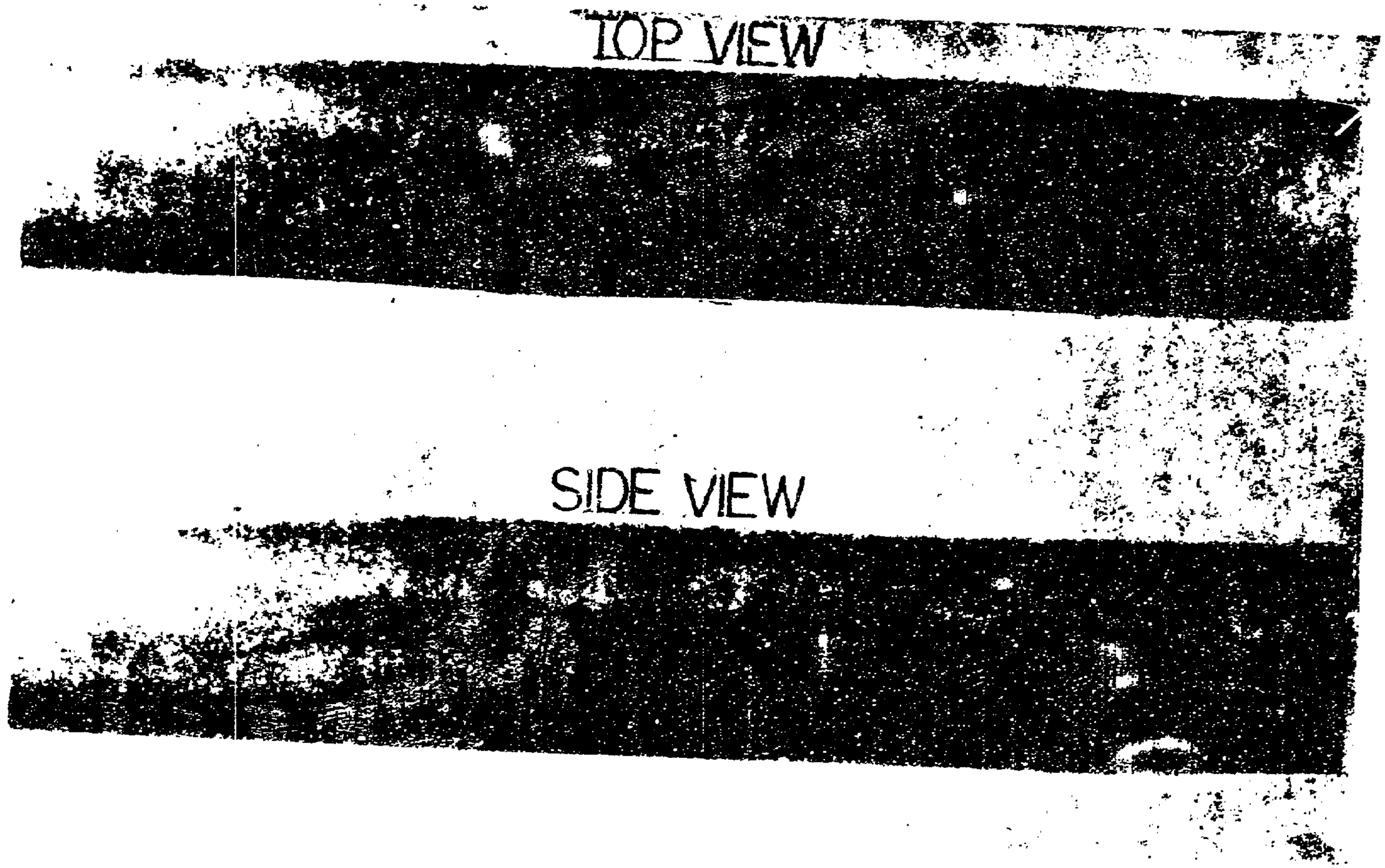


Figure 85. Flechette In-Bore Position

is a chief catalyst in causing the initial conditions. An asymmetric blast can indeed impart influence on the initial conditions, b[illegible]ymmetric blast can also. Given an initial angle of attack due to so[illegible]disturbances the symmetric blast can cause significant $\vec{\alpha}_o$, $\vec{\dot{\alpha}}_o$, $\vec{\dot{S}}_o$ and $\vec{S}_o$. Figure 86 shows a typical blast region with the flechette outlined in the picture. The momentum principle discussed in the previous section goes hand-in-hand with this blast region. It is here that the transverse and angular-momentum is imparted to the flechette. Figure 87 illustrates a typical flechette in the blast region. Coming out of the barrel at some angle of attack, the blast catches the flechette and induces some angular rate. At the same time, the flechette is translated laterally giving an $\vec{S}_o$ and $\vec{\dot{S}}_o$. If these contributions cancel each other out; that is, if initial transverse momentum equals initial angular momentum then the dispersion is zero. If they do not cancel, dispersion results. The sketch is highly simplified in that the blast itself is all-engulfing as in Figure 86. Of course, the transition sequence of sabot separation, fin interference, and possible fin damage must not be forgotten. The transition sequence occurs in the blast region, however, and is not considered separate from the blast. When separation occurs, the sabot particles are apt to interfere with the fin section and cause possible damage. Once the sabot has separated and cleared the fins the blast has had its greatest effect and the initial conditions can be determined. After the flechette has moved downrange, it assumes supersonic free flight, Figure 88.

Figure 86. Typical Flechette Blast Region

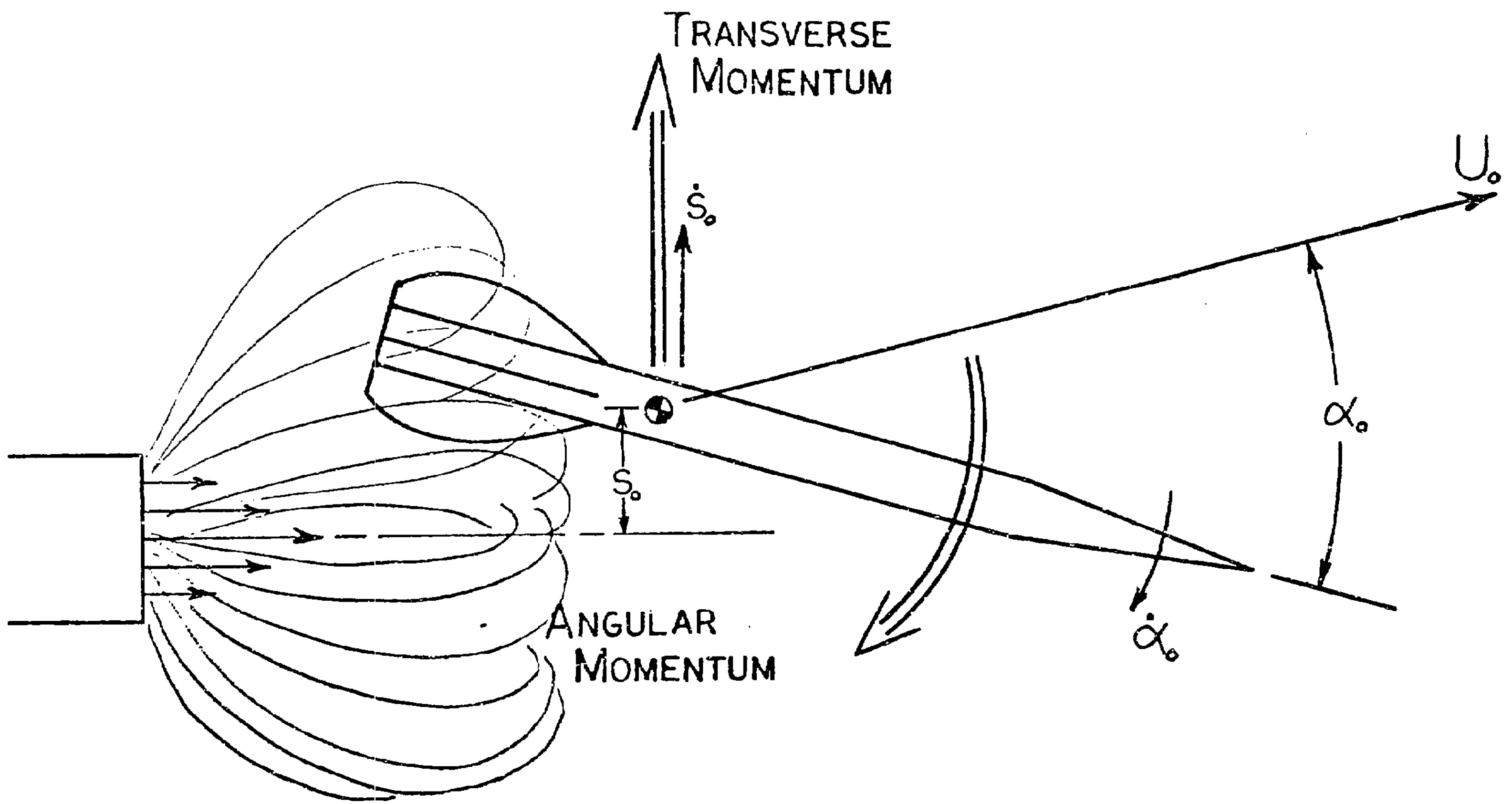


Figure 87. Muzzle Blast Effects

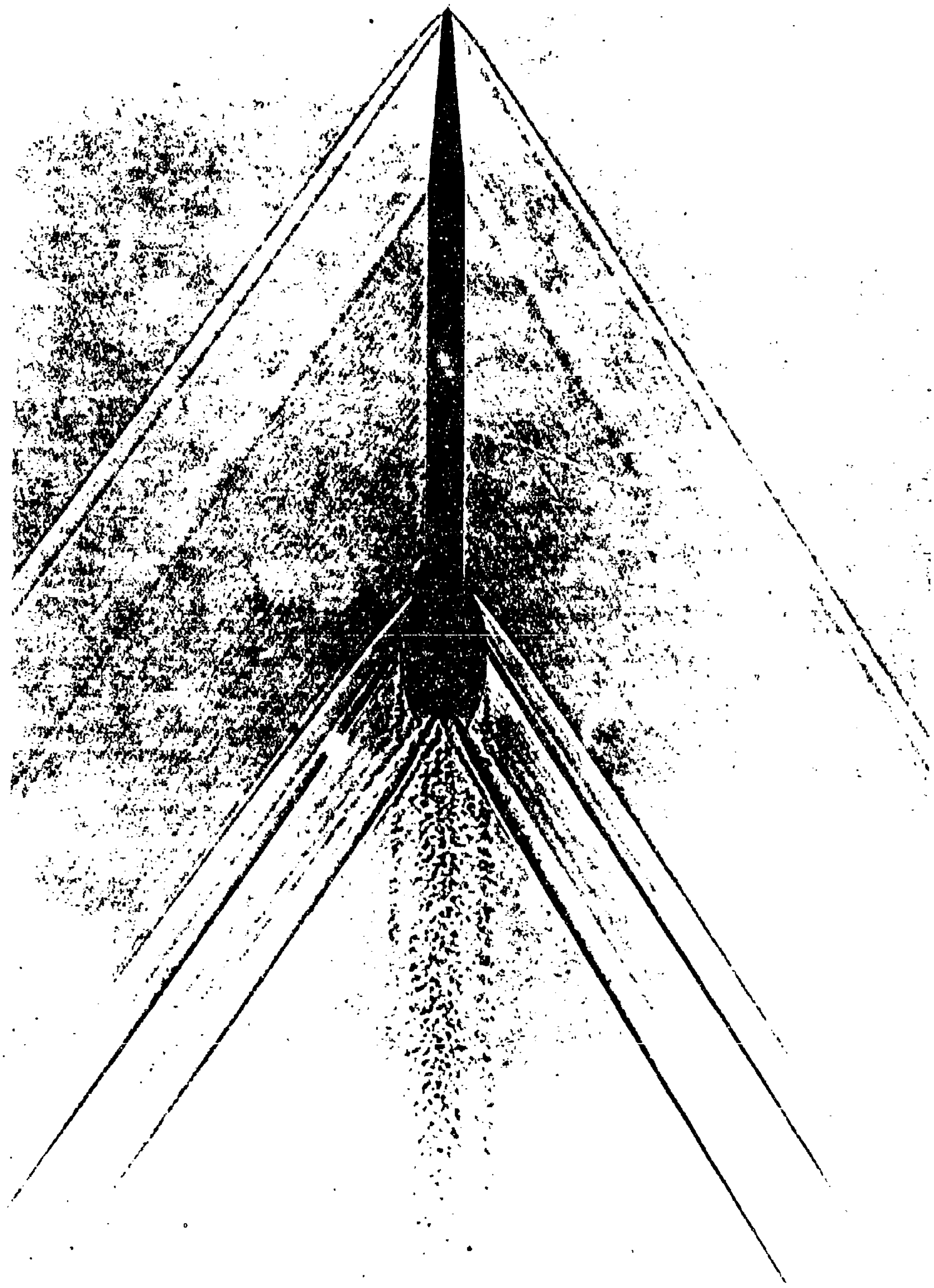


Figure 88. Supersonic Free Flight, Ground Point Flechette

CONCLUSIONS

A complete Jump and Dispersion Theory has been developed for free flight vehicles. Three governing equations have been determined to accommodate high, low, and very low roll rates. The theories were found to be accurate with six-degree-of-freedom numerical computations of the equations of motion and therefore reliably predict the jump and dispersion of flechettes. The theory validation included 201 case runs in four phases. The first phase validated the theory with respect to restoring and damping moments. The effect of these moments on dispersion was found to depend on the initial conditions. The second phase validated the theory with respect to Magnus forces and moments. The effect of Magnus was found to be very small and not to be of any consequence unless the total dispersion of any given round was of the same order of magnitude as the Magnus effect. Phase three validates the theory with respect to aerodynamic asymmetries and roll rate. All three theories were validated in this phase and found to be quite accurate considering the large dispersions encountered. Aerodynamic asymmetries causing a trim angle of 1^{o} had little effect on the dispersion of flechettes. Slower rolling bodies were shown to have, in general, increasingly larger dispersion values as roll rate decreased. It can be concluded that for free flight vehicles that are prone to aerodynamic asymmetries and fin damage, a high roll rate is essential to lower dispersion and increase accuracy. The fourth phase validates the theory with respect to gravity. The theory indicates a lateral contribution to dispersion from gravity in addition to the obvious vertical contribution.

For the flechette, the lateral contribution was found to be minimal and was neglected in this analysis.

Free flight data was obtained from Frankford Arsenal to correlate with the theory. Angular and translational data was fitted and put into initial condition form. The initial condition data was applied to the theory and compared to target data for the rounds tested. The theory was found to agree favorably in magnitude with the test firings. As a result, the method used to analyze the data can be considered a valid method. Photographs of the test firings were taken to include the flight transition sequence in the blast region. The pictures further verify the analysis method of the initial conditions by allowing agreement between the chosen initial conditions and the position downrange where they were selected.

The evaluation of the free flight dispersion against the theory also disproves the First Maximum Yaw hypothesis. A plot of jump angle vs. first maximum yaw of actual test data produced a shotgun blast pattern with no relationship evident between dispersion and first maximum yaw. In addition, a plot of jump angle versus angular rate for various initial angles of attack indicates an infinite amount of combinations of initial conditions to yield a given jump angle. Thus, zero dispersion has an infinite set of possible initial conditions. It was found for zero dispersion that a unique physical condition holds: to obtain zero dispersion, initial transverse momentum = initial angular momentum. These impulses are imparted to the flechette in the blast region where the body and especially the fins are subject to disturbances. Momentum imbalance is the reason dispersion occurs. The initial conditions only determine the magnitude of imbalance or dispersion. This dispersion is round to round dispersion. Inconsistency in the imbalance results in a dispersion pattern. The initial conditions were found not to occur until after the sabot separation and the blast has had its greatest effect. The factors causing the existence of initial conditions were found to be not only the blast and sabot separation sequence, but also fin and body asymmetries and bore mal-alignment. In order to decrease dispersion, these physical factors causing initial conditions must be kept at a minimum. The most important aspect would be to protect the fins from asymmetries, damage, and interference from the separating sabot. Initial conditions can never realistically be eliminated but if kept minimal, dispersion is reduced.

APPENDIX

A-1

Appendix A1 contains mass parameters and stability coefficients for the Ground Point Flechette. Table A1-1 lists values for mass, diameter, axial and transverse moments of inertia. Figures A1-1 through A1-8 present stability coefficients used in this analysis versus Mach number. C_{Z_α}, C_{M_α}, $C_{M_q} + C_{M_{\dot{\alpha}}}$ were provided by Frankford Arsenal. $C_{Z_{p\beta}}$, $C_{M_{p\beta}}$, C_{YE}, C_{ZE}, C_{ME}, C_{NE} were nominal values of the coefficients following the same trends of C_{Z_α} and C_{M_α} for Mach number. C_{M_α} and C_{M_q} $C_{M_{\dot{\alpha}}}$ were verified in the University of Notre Dame supersonic wind tunnel.[16]

TABLE A1-1

FLECHETTE PARAMETERS

mass	=	0.000046 slugs
diameter	=	0.006 ft.
I_x	=	0.000000000217 slugs-ft^2
I_y	=	0.000000036421 slugs-ft^2

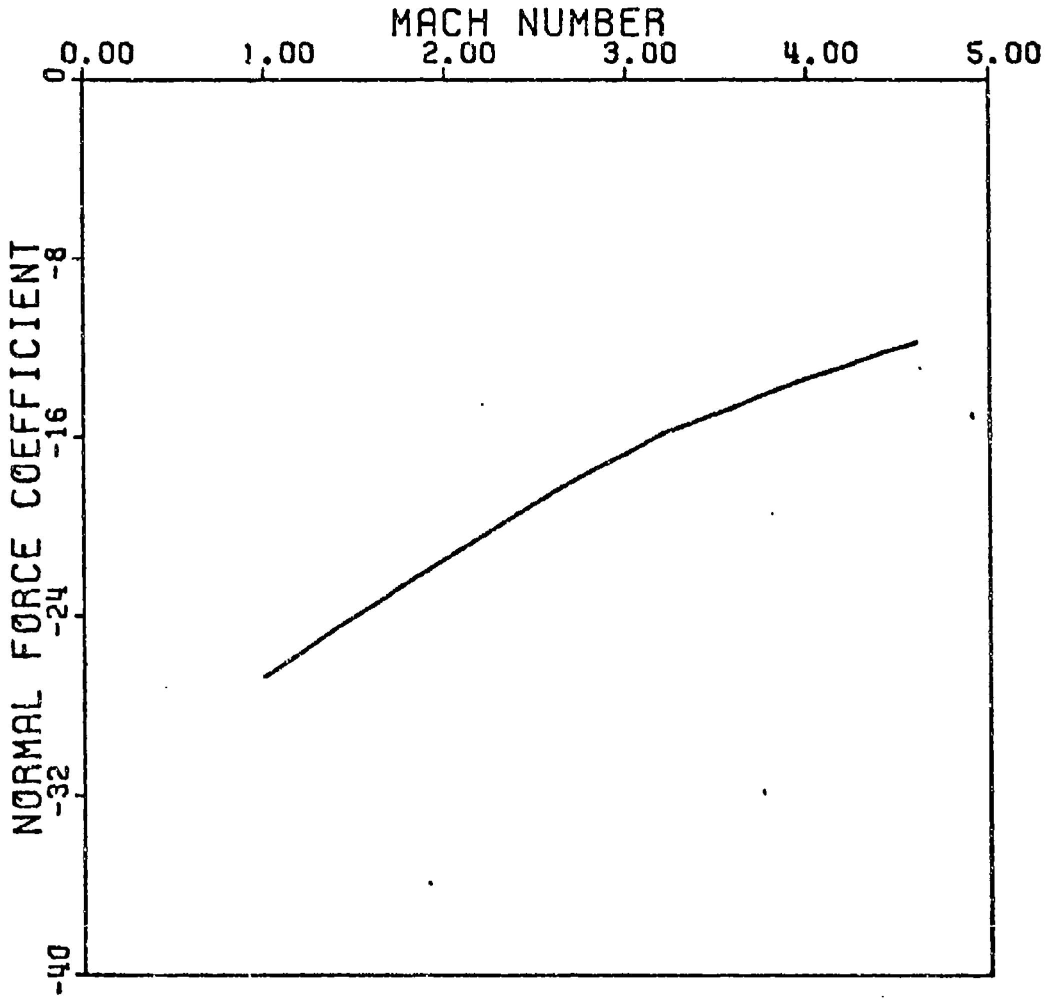


Figure A1-1. CZα vs Mach Number Producibility Ground Point

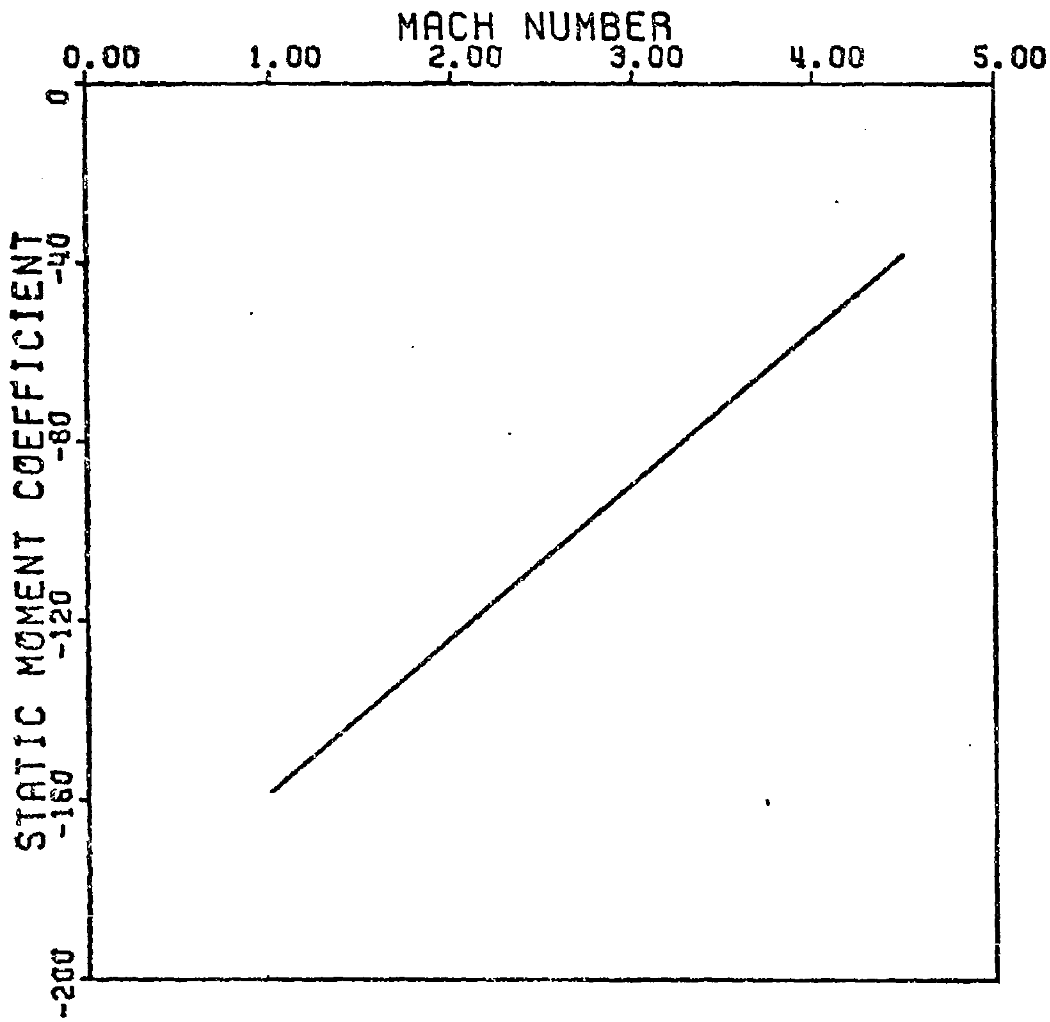


Figure A1-2. CMα vs Mach Number Producibility Ground Point

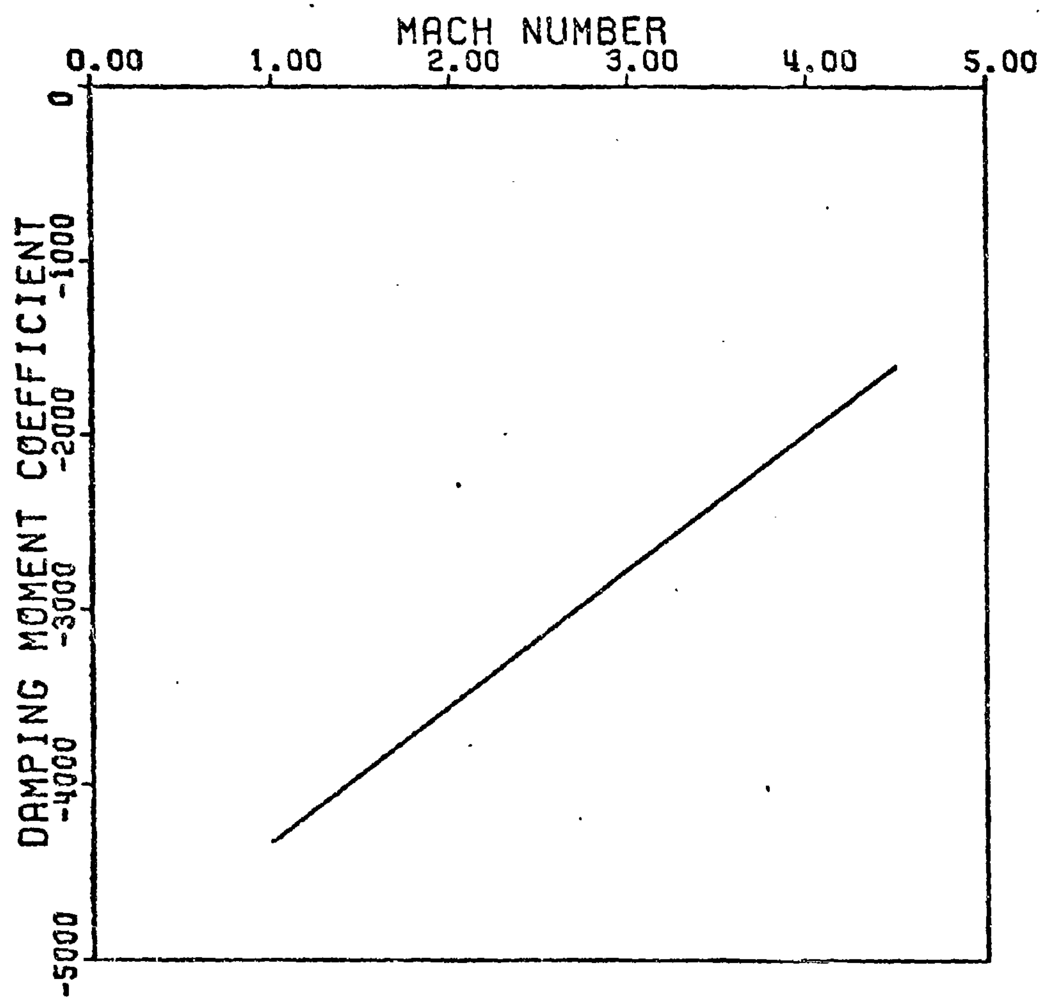


Figure A1-3. CMq + CMα̇ vs Mach Number Producibility Ground Point

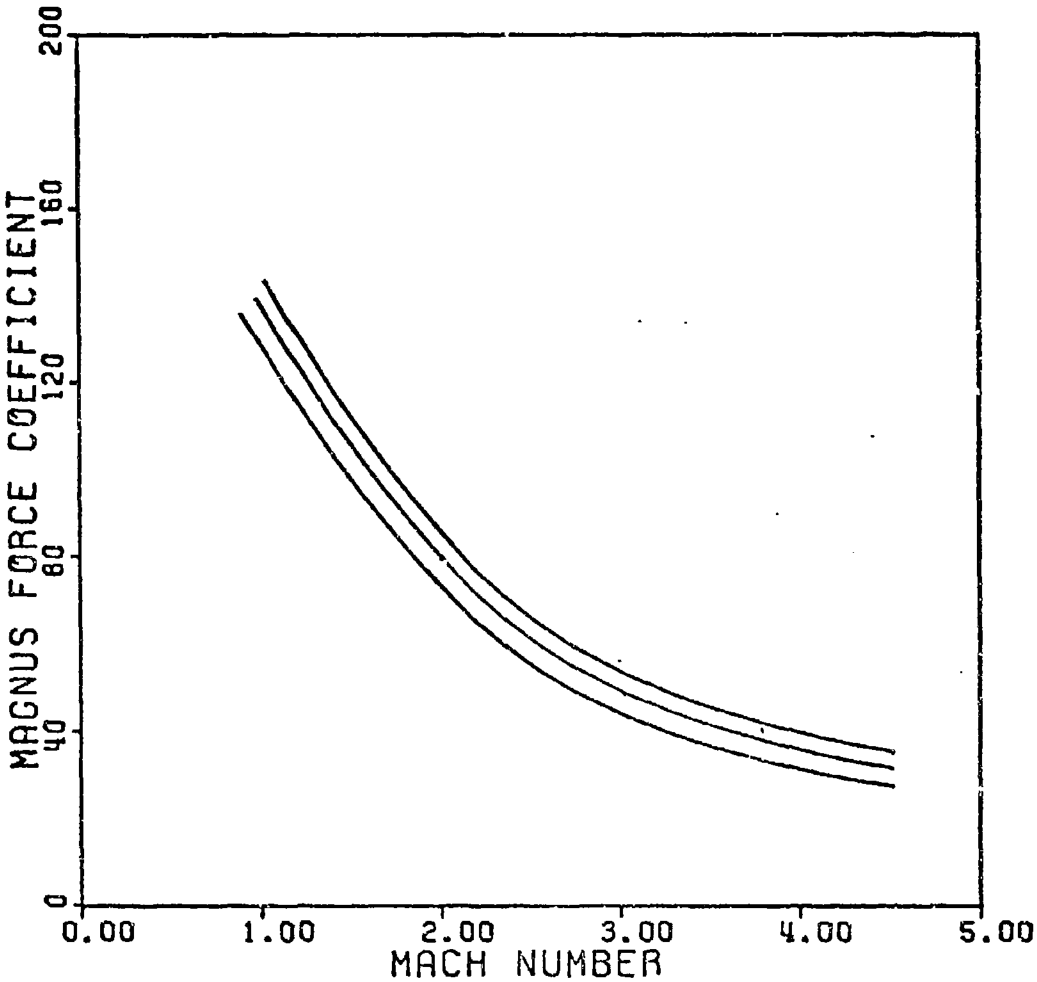


Figure A1-4. CZpo vs Mach Number Producibility Ground Point

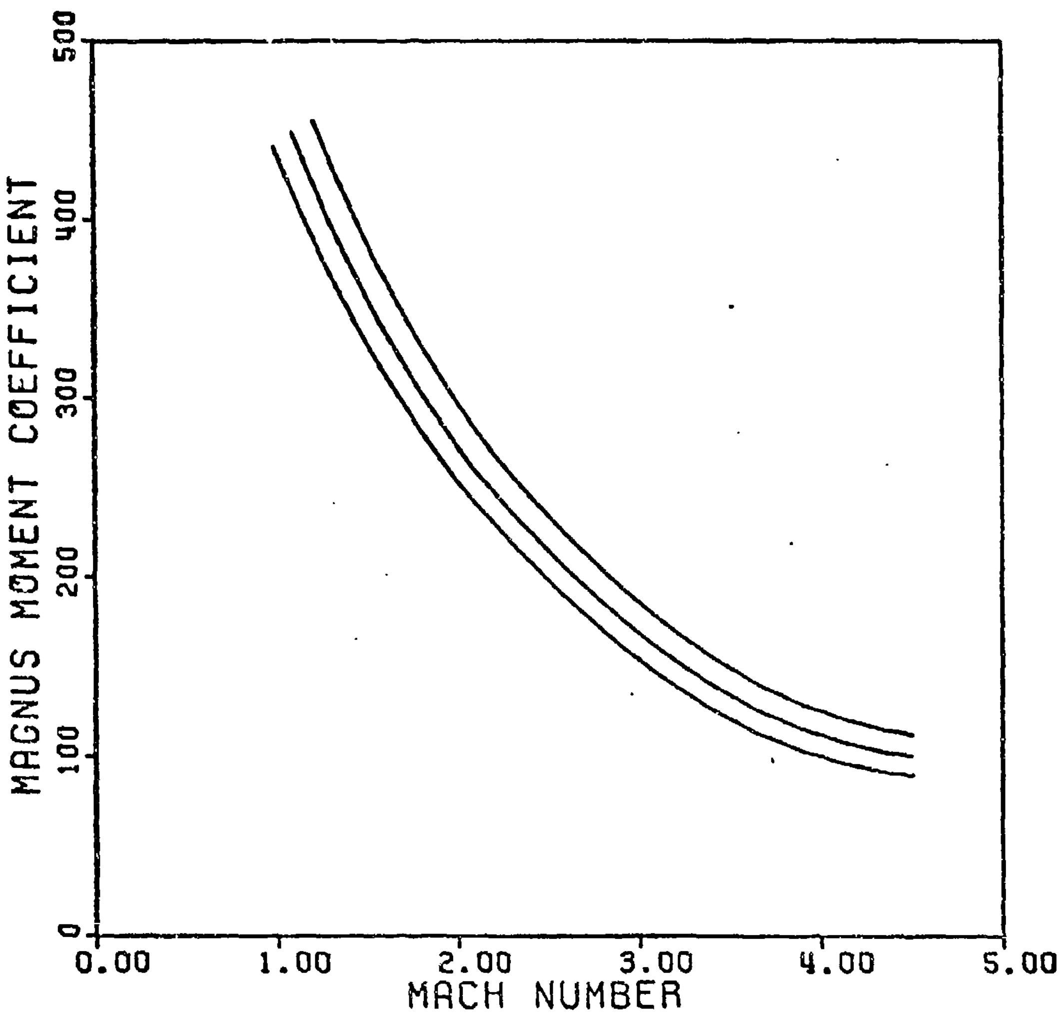


Figure A1-5. CMpb vs Mach Number Producibility Ground Point

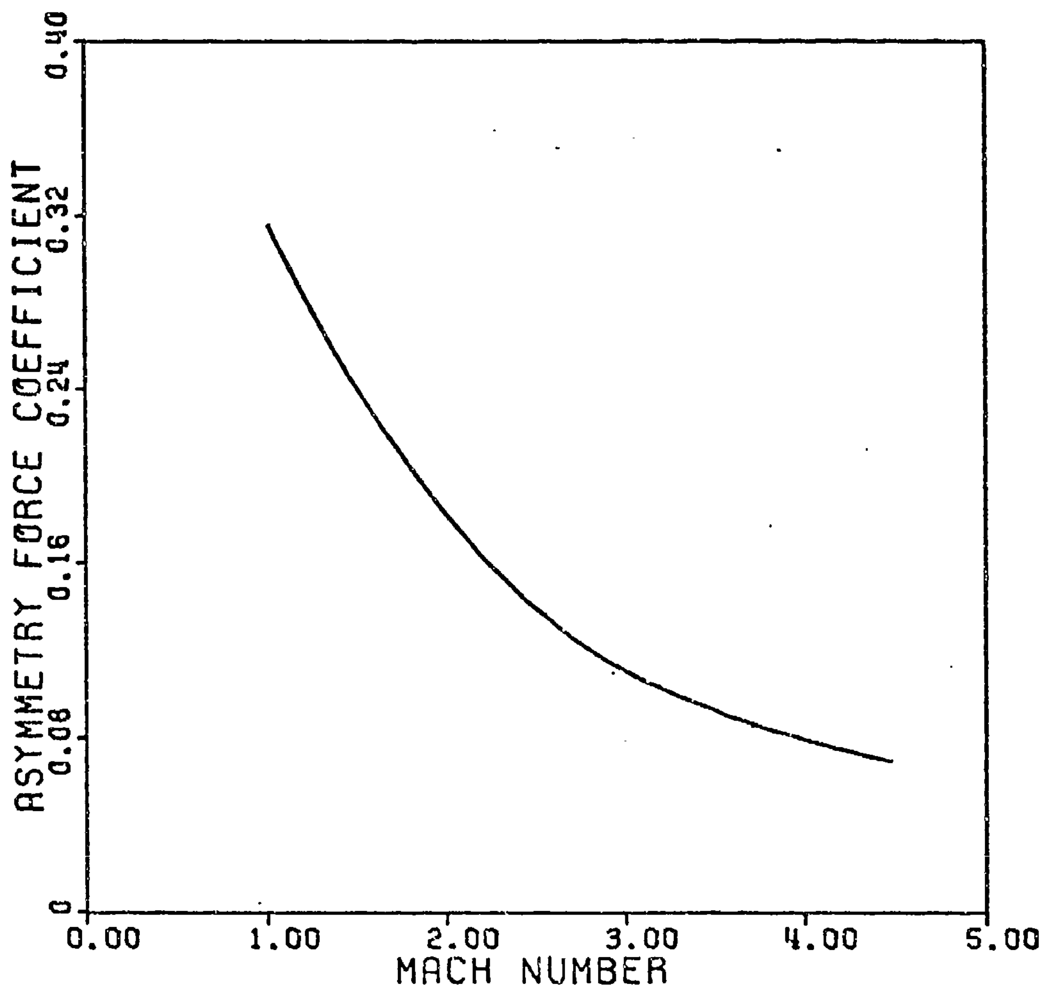


Figure A1-6. CYE, CZE vs Mach Number Producibility Ground Point

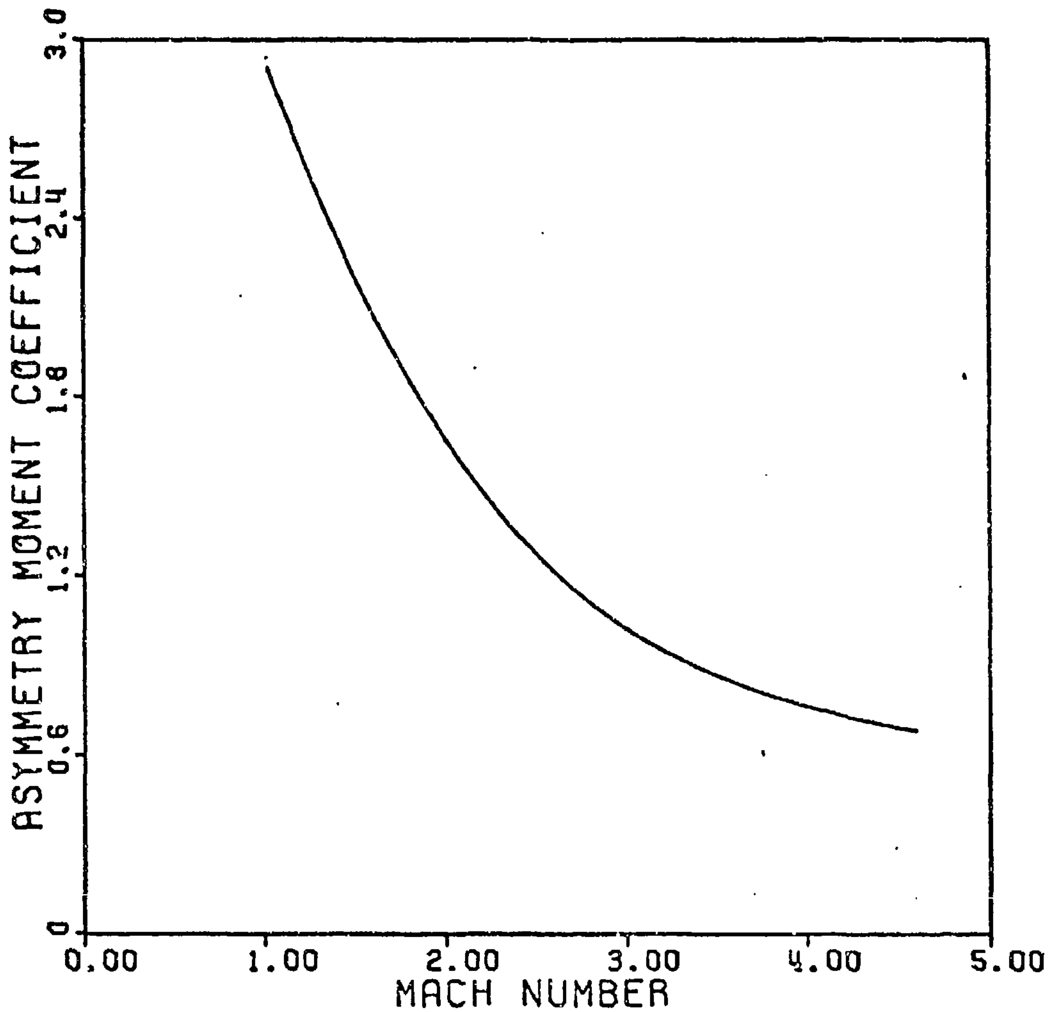


Figure A1-7. CME vs Mach Number Producibility Ground Point

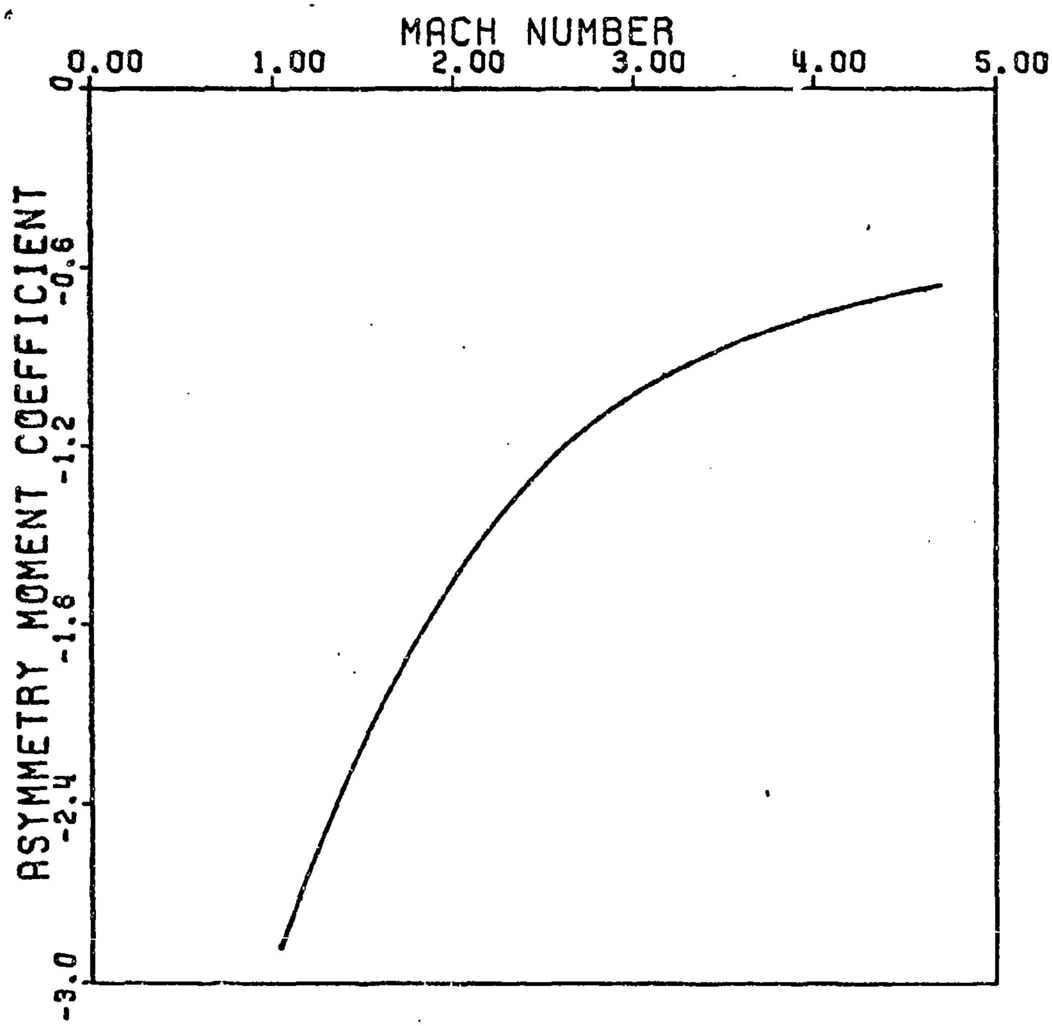


Figure A1-8. CNE vs Mach Number Producibility Ground Point

APPENDIX

A-2

Appendix A-2 contains the complete print-out of the results from a typical 6-D computer program run. The results give the time from launch, position coordinates x,y,z, velocity, roll rate, the magnitude of the complex angle of attack, Mach number, roll orientation angle, angles of pitch and yaw, nutation and precession damping factors, nutation and precession mode frequency rates, the gyroscopic stability factor, dynamic weight factor, and trim angle.

The program is divided into various subroutines to eliminate any superfluous calculations. These subroutines read in aerodynamic coefficients in tabular form as functions of Mach number and angle of attack, initialize the data, and integrate the six-degrees-of-freedom differential equations of motion using a four-step Runge-Kutta scheme to obtain the vehicle trajectory.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	Y-N R/D/SEC	W-D RAD/SEC	S	TAU	Y-T DEG
0.0	0.0	0.0	0.0	5000.0	500.00	0.0	4.49	0.0	0.0	0.0	-55.	-55.	2317.	-2317.	-0.	0.	0.
0.0001	0.50	0.000	-0.000	5000.0	500.00	2.04	4.49	47.84	1.44	1.44	-55.	-55.	2317.	-2315.	-0.	0.	1.
0.0002	1.00	0.000	-0.000	4999.9	500.00	4.01	4.49	50.64	2.84	2.83	-55.	-56.	2313.	-2315.	-0.	0.	1.
0.0003	1.50	0.000	-0.000	4999.8	500.00	5.83	4.49	53.40	4.14	4.11	-55.	-56.	2314.	-2315.	-0.	0.	1.
0.0004	2.00	0.000	-0.000	4999.5	500.00	7.39	4.48	55.12	5.25	5.20	-55.	-56.	2314.	-2316.	-0.	0.	1.
0.0005	2.50	0.001	-0.001	4999.1	500.00	8.52	4.48	56.79	6.17	6.07	-55.	-56.	2312.	-2315.	-0.	0.	1.
0.0006	3.00	0.002	-0.002	4998.6	500.00	9.44	4.48	61.39	6.77	6.58	-55.	-56.	2314.	-2315.	-0.	0.	1.
0.0007	3.50	0.003	-0.003	4998.0	500.00	9.83	4.48	63.93	7.09	6.81	-55.	-56.	2316.	-2315.	-0.	0.	1.
0.0008	4.00	0.004	-0.005	4997.4	500.00	9.75	4.48	65.29	7.10	6.70	-55.	-56.	2314.	-2315.	-0.	0.	1.
0.0009	4.50	0.005	-0.006	4996.9	500.00	9.24	4.48	67.47	6.73	6.26	-55.	-56.	2315.	-2316.	-0.	0.	1.
0.0010	5.00	0.007	-0.007	4996.3	500.00	8.33	4.48	70.35	6.20	5.92	-55.	-56.	2319.	-2316.	-0.	0.	1.
0.0011	5.50	0.009	-0.009	4995.9	500.00	7.01	4.47	71.66	5.36	4.51	-55.	-56.	2319.	-2316.	-0.	0.	1.
0.0012	6.00	0.011	-0.011	4995.7	500.00	5.43	4.47	71.93	4.31	3.39	-55.	-56.	2320.	-2317.	-0.	0.	1.
0.0013	6.50	0.013	-0.013	4995.5	500.00	3.67	4.47	69.07	3.12	1.93	-55.	-56.	2320.	-2317.	-0.	0.	1.
0.0014	7.00	0.015	-0.015	4995.5	500.00	1.91	4.47	55.31	1.55	0.42	-55.	-56.	2320.	-2317.	-0.	0.	1.
0.0015	7.50	0.018	-0.017	4995.5	500.00	1.11	4.47	343.34	0.55	-0.95	-55.	-56.	2320.	-2317.	-0.	0.	1.
0.0016	8.00	0.020	-0.020	4995.5	500.00	2.43	4.47	300.03	-0.54	-2.34	-55.	-56.	2321.	-2317.	-0.	0.	1.
0.0017	8.50	0.022	-0.022	4995.4	500.00	3.99	4.47	282.40	-1.77	-3.37	-55.	-56.	2320.	-2317.	-0.	0.	1.
0.0018	9.00	0.025	-0.024	4995.2	500.00	5.34	4.47	281.41	-2.70	-4.61	-55.	-56.	2320.	-2317.	-0.	0.	1.
0.0019	9.49	0.027	-0.025	4995.0	500.00	6.38	4.47	287.44	-3.33	-5.40	-55.	-56.	2320.	-2317.	-0.	0.	1.
0.0020	9.99	0.029	-0.027	4994.7	500.00	7.04	4.47	294.49	-3.83	-5.90	-55.	-56.	2320.	-2317.	-0.	0.	1.
0.0021	10.49	0.030	-0.029	4994.3	500.00	7.29	4.47	297.18	-3.91	-5.13	-55.	-56.	2320.	-2317.	-0.	0.	1.
0.0022	10.99	0.032	-0.030	4993.9	500.00	7.13	4.47	300.43	-3.96	-6.13	-55.	-56.	2320.	-2317.	-0.	0.	1.
0.0023	11.49	0.034	-0.030	4993.6	500.00	6.53	4.47	304.36	-3.65	-5.63	-55.	-56.	2320.	-2317.	-0.	0.	1.
0.0024	11.99	0.035	-0.031	4993.4	500.00	5.57	4.47	309.27	-2.81	-4.93	-55.	-56.	2321.	-2317.	-0.	0.	1.
0.0025	12.49	0.036	-0.032	4993.2	500.00	4.48	4.47	316.05	-1.74	-4.04	-55.	-56.	2321.	-2317.	-0.	0.	1.
0.0026	12.99	0.037	-0.032	4993.1	500.00	3.11	4.47	327.39	-0.42	-2.97	-55.	-55.	2321.	-2318.	-0.	0.	1.
0.0027	13.49	0.038	-0.032	4993.1	500.00	1.81	4.47	353.83	0.20	-1.83	-55.	-55.	2321.	-2318.	-0.	0.	1.
0.0028	13.99	0.039	-0.033	4993.0	500.00	1.48	4.47	57.38	1.37	-0.58	-55.	-55.	2321.	-2318.	-0.	0.	1.
0.0029	14.49	0.040	-0.033	4993.0	500.00	2.58	4.47	95.95	2.50	0.51	-55.	-55.	2321.	-2318.	-0.	0.	1.
0.0030	14.99	0.042	-0.033	4993.0	500.00	3.95	4.47	111.75	3.55	1.72	-55.	-55.	2321.	-2318.	-0.	0.	1.
0.0031	15.49	0.043	-0.033	4992.8	500.00	5.19	4.47	119.79	4.44	2.65	-55.	-56.	2321.	-2318.	-0.	0.	1.
0.0032	15.99	0.044	-0.034	4992.6	500.00	6.19	4.47	125.07	5.17	3.41	-55.	-56.	2321.	-2318.	-0.	0.	1.
0.0033	16.49	0.046	-0.035	4992.3	500.00	6.97	4.47	129.23	5.55	3.91	-55.	-56.	2321.	-2318.	-0.	0.	1.
0.0034	16.98	0.048	-0.035	4992.0	500.00	7.15	4.47	132.59	5.87	4.14	-55.	-56.	2321.	-2318.	-0.	0.	1.
0.0035	17.48	0.050	-0.036	4991.6	500.00	7.11	4.47	135.33	5.82	4.08	-55.	-56.	2321.	-2318.	-0.	0.	1.
0.0036	17.98	0.052	-0.037	4991.3	500.00	6.46	4.47	137.43	5.50	3.75	-55.	-56.	2322.	-2318.	-0.	0.	1.
0.0037	18.48	0.054	-0.037	4991.0	500.00	5.35	4.47	138.45	4.84	3.15	-55.	-56.	2322.	-2319.	-0.	0.	1.
0.0038	18.98	0.057	-0.040	4990.9	500.00	4.76	4.47	138.35	4.15	2.34	-55.	-56.	2322.	-2318.	-0.	0.	1.
0.0039	19.48	0.060	-0.041	4990.7	500.00	3.45	4.47	134.65	3.19	1.36	-55.	-56.	2322.	-2318.	-0.	0.	1.
0.0040	19.98	0.063	-0.043	4990.7	500.00	2.09	4.47	127.35	2.09	0.21	-55.	-56.	2322.	-2319.	-0.	0.	1.
0.0041	20.48	0.066	-0.045	4990.7	500.00	1.34	4.47	70.23	0.91	-0.98	-55.	-56.	2322.	-2319.	-0.	0.	1.
0.0042	20.98	0.069	-0.046	4990.7	500.00	2.20	4.47	23.11	-0.74	-2.18	-55.	-56.	2322.	-2319.	-0.	0.	1.
0.0043	21.48	0.072	-0.048	4990.6	500.00	3.62	4.47	10.15	-1.42	-3.32	-55.	-55.	2322.	-2319.	-0.	0.	1.
0.0044	21.98	0.075	-0.049	4990.5	500.00	5.00	4.47	6.49	-2.46	-4.35	-55.	-56.	2322.	-2319.	-0.	0.	1.
0.0045	22.47	0.077	-0.050	4990.3	500.00	6.15	4.47	6.31	-3.35	-5.23	-55.	-57.	2322.	-2319.	-0.	0.	1.
0.0046	22.97	0.080	-0.051	4990.0	500.00	7.10	4.47	7.30	-4.04	-5.84	-55.	-57.	2322.	-2319.	-0.	0.	1.
0.0047	23.47	0.083	-0.052	4989.7	500.00	7.55	4.47	9.00	-4.50	-6.24	-55.	-57.	2322.	-2319.	-0.	0.	1.
0.0048	23.97	0.085	-0.053	4989.3	500.00	7.93	4.47	11.14	-4.72	-6.37	-55.	-57.	2322.	-2319.	-0.	0.	1.
0.0049	24.47	0.087	-0.053	4988.9	500.00	7.60	4.47	13.60	-4.63	-6.23	-55.	-57.	2323.	-2320.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	F-T DEG
0.0050	24.97	0.089	-0.053	4988.5	500.00	7.32	4.47	16.33	-4.42	-5.86	-55.	-57.	2323.	-2320.	-0.	0.	1.
0.0051	25.47	0.091	-0.054	4988.2	500.00	6.52	4.47	19.34	-3.92	-5.21	-55.	-57.	2323.	-2320.	-0.	0.	1.
0.0052	25.97	0.093	-0.053	4988.0	500.00	5.45	4.47	22.73	-3.24	-4.39	-55.	-57.	2323.	-2320.	-0.	0.	1.
0.0053	26.47	0.094	-0.053	4987.8	500.00	4.17	4.47	26.80	-2.41	-3.41	-55.	-57.	2323.	-2320.	-0.	0.	1.
0.0054	26.96	0.096	-0.053	4987.8	500.00	2.76	4.47	32.52	-1.49	-2.33	-55.	-57.	2323.	-2320.	-0.	0.	1.
0.0055	27.46	0.097	-0.052	4987.7	500.00	1.31	4.47	45.12	-0.51	-1.71	-55.	-57.	2323.	-2320.	-0.	0.	1.
0.0056	27.96	0.099	-0.052	4987.7	500.00	0.47	4.47	148.05	0.45	-0.10	-55.	-57.	2323.	-2320.	-0.	0.	1.
0.0057	28.46	0.100	-0.051	4987.7	500.00	1.66	4.47	193.00	1.35	0.83	-55.	-57.	2323.	-2320.	-0.	0.	1.
0.0058	28.96	0.102	-0.051	4987.7	500.00	2.81	4.47	207.10	2.13	1.83	-55.	-57.	2323.	-2320.	-0.	0.	1.
0.0059	29.46	0.104	-0.050	4987.6	500.00	3.76	4.47	212.31	2.71	2.67	-55.	-57.	2323.	-2320.	-0.	0.	1.
0.0060	29.96	0.105	-0.050	4987.5	500.00	4.42	4.47	216.41	3.14	3.09	-55.	-57.	2323.	-2320.	-0.	0.	1.
0.0061	30.46	0.107	-0.050	4987.3	500.00	4.76	4.47	220.12	3.37	3.39	-55.	-57.	2323.	-2320.	-0.	0.	1.
0.0062	30.95	0.109	-0.050	4987.1	500.00	4.94	4.47	223.47	3.34	3.45	-55.	-57.	2323.	-2320.	-0.	0.	1.
0.0063	31.45	0.111	-0.050	4987.0	500.00	4.49	4.47	227.23	3.03	3.26	-55.	-57.	2323.	-2321.	-0.	0.	1.
0.0064	31.95	0.114	-0.050	4986.8	500.00	3.87	4.47	230.97	2.61	2.83	-55.	-57.	2324.	-2321.	-0.	0.	1.
0.0065	32.45	0.116	-0.051	4986.7	500.00	2.98	4.47	235.35	1.95	2.25	-55.	-57.	2324.	-2321.	-0.	0.	1.
0.0066	32.95	0.118	-0.051	4985.7	500.00	1.87	4.47	241.67	1.14	[illegible]	-55.	-57.	2324.	-2321.	-0.	0.	1.
0.0067	33.45	0.121	-0.052	4985.7	500.00	0.64	4.47	262.74	0.21	0.61	-55.	-57.	2324.	-2321.	-0.	0.	1.
0.0068	33.95	0.123	-0.052	4985.7	500.00	0.85	4.47	38.24	-0.78	-0.34	-55.	-57.	2324.	-2321.	-0.	0.	1.
0.0069	34.44	0.126	-0.053	4985.7	500.00	2.20	4.47	53.61	-1.79	-1.28	-55.	-57.	2324.	-2321.	-0.	0.	1.
0.0070	34.94	0.129	-0.053	4985.6	500.00	3.51	4.47	59.24	-2.74	-2.19	-55.	-57.	2324.	-2321.	-0.	0.	1.
0.0071	35.44	0.131	-0.054	4985.5	500.00	4.70	4.47	63.15	-3.62	-3.00	-55.	-57.	2324.	-2321.	-0.	0.	1.
0.0072	35.94	0.133	-0.054	4986.3	500.00	5.69	4.47	65.42	-4.36	-3.46	-55.	-57.	2324.	-2321.	-0.	0.	1.
0.0073	36.44	0.135	-0.054	4985.1	500.00	6.44	4.47	69.33	-4.93	-4.15	-55.	-57.	2324.	-2321.	-0.	0.	1.
0.0074	36.94	0.137	-0.055	4985.8	500.00	6.90	4.47	71.97	-5.30	-4.42	-55.	-57.	2324.	-2321.	-0.	0.	1.
0.0075	37.44	0.139	-0.055	4985.5	500.00	7.06	4.47	74.34	-5.46	-4.49	-55.	-57.	2324.	-2321.	-0.	0.	1.
0.0076	37.93	0.141	-0.054	4985.2	500.00	6.50	4.47	76.45	-5.32	-4.30	-55.	-57.	2324.	-2321.	-0.	0.	1.
0.0077	38.43	0.142	-0.054	4984.9	500.00	6.44	4.47	78.14	-5.12	-3.91	-55.	-57.	2324.	-2321.	-0.	0.	1.
0.0078	38.93	0.143	-0.053	4984.7	500.00	5.71	4.46	79.13	-4.64	-3.32	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0079	39.43	0.144	-0.053	4984.5	500.00	4.75	4.46	79.09	-4.00	-2.56	-55.	-57.	2324.	-2322.	-0.	0.	1.
0.0080	39.93	0.145	-0.052	4984.4	500.00	3.63	4.46	75.72	-3.23	-1.67	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0081	40.43	0.146	-0.051	4984.3	500.00	2.45	4.46	68.61	-2.35	-0.53	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0082	40.93	0.147	-0.050	4984.3	500.00	1.49	4.46	42.78	-1.45	0.32	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0083	41.42	0.148	-0.049	4984.3	500.00	1.42	4.46	350.50	-0.53	1.31	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0084	41.92	0.148	-0.048	4984.3	500.00	2.26	4.46	323.12	0.31	2.24	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0085	42.42	0.149	-0.046	4984.2	500.00	3.24	4.46	314.54	1.05	3.05	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0086	42.92	0.150	-0.047	4984.2	500.00	4.10	4.46	312.37	1.63	3.73	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0087	43.42	0.151	-0.047	4984.0	500.00	4.74	4.46	312.46	2.14	4.23	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0088	43.92	0.152	-0.046	4983.9	500.00	5.12	4.46	314.30	2.41	4.52	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0089	44.41	0.153	-0.046	4983.7	500.00	5.22	4.46	316.89	2.49	4.50	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0090	44.91	0.154	-0.046	4983.5	500.00	5.05	4.45	321.29	2.35	4.41	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0091	45.41	0.155	-0.046	4983.3	500.00	4.62	4.46	324.69	2.06	4.14	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0092	45.91	0.157	-0.047	4983.2	500.00	3.96	4.46	330.33	1.57	3.64	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0093	46.41	0.158	-0.047	4983.1	500.00	3.14	4.46	339.03	0.95	3.00	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0094	46.91	0.160	-0.047	4983.1	500.00	2.26	4.46	353.44	0.24	2.25	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0095	47.40	0.161	-0.048	4983.1	500.00	1.54	4.46	22.59	-0.53	1.44	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0096	47.90	0.163	-0.049	4983.1	500.00	1.65	4.46	59.93	-1.31	0.62	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0097	48.40	0.164	-0.049	4983.0	500.00	2.07	4.46	102.65	-2.07	-0.17	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0098	48.90	0.166	-0.050	4983.0	500.00	2.88	4.46	112.65	-2.76	-0.85	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0099	49.40	0.167	-0.051	4982.9	500.00	3.62	4.46	127.75	-3.31	-1.47	-55.	-57.	2325.	-2322.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	$\overline{\text{ALPHA}}$ DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	K-N RAD/SEC	K-P RAD/SEC	S	TAU	K-T DEG
0.0100	49.90	0.168	-0.051	4982.8	500.00	4.19	4.46	133.93	-3.73	-1.92	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0101	50.39	0.169	-0.052	4982.7	500.00	4.54	4.46	135.30	-3.93	-2.19	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0102	50.89	0.170	-0.052	4982.5	500.00	4.54	4.46	141.63	-4.05	-2.27	-55.	-57.	2325.	-2322.	-0.	0.	1.
0.0103	51.39	0.171	-0.052	4982.4	500.00	4.49	4.46	144.12	-3.93	-2.17	-55.	-57.	2325.	-2323.	-0.	0.	1.
0.0104	51.89	0.172	-0.052	4982.3	500.00	4.08	4.46	145.49	-3.62	-1.93	-55.	-57.	2325.	-2323.	-0.	0.	1.
0.0105	52.39	0.172	-0.052	4982.2	500.00	3.45	4.46	145.20	-3.15	-1.42	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0106	52.89	0.173	-0.052	4982.1	500.00	2.66	4.46	141.72	-2.53	-0.81	-55.	-57.	2325.	-2323.	-0.	0.	1.
0.0107	53.38	0.173	-0.052	4982.1	500.00	1.90	4.46	131.04	-1.73	-0.10	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0108	53.88	0.173	-0.052	4982.1	500.00	1.19	4.46	93.31	-0.95	0.63	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0109	54.38	0.174	-0.052	4982.0	500.00	1.49	4.46	47.62	-0.13	1.49	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0110	54.88	0.174	-0.052	4982.0	500.00	2.39	4.46	29.07	0.71	2.25	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0111	55.38	0.174	-0.052	4982.0	500.00	3.35	4.46	21.70	1.51	3.02	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0112	55.87	0.174	-0.052	4981.9	500.00	4.28	4.46	19.87	2.22	3.65	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0113	56.37	0.175	-0.052	4981.7	500.00	5.06	4.46	19.97	2.92	4.17	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0114	56.87	0.175	-0.053	4981.6	500.00	5.55	4.46	21.05	3.27	4.53	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0115	57.37	0.176	-0.053	4981.4	500.00	5.90	4.46	22.71	3.55	4.71	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0116	57.87	0.177	-0.054	4981.1	500.00	5.97	4.46	24.72	3.56	4.71	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0117	58.36	0.177	-0.055	4980.9	500.00	5.78	4.46	26.97	3.50	4.53	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0118	58.86	0.178	-0.056	4980.7	500.00	5.36	4.46	29.40	3.37	4.17	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0119	59.36	0.180	-0.057	4980.6	500.00	4.73	4.46	31.98	2.99	3.57	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0120	59.86	0.181	-0.058	4980.5	500.00	3.93	4.46	34.70	2.47	3.06	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0121	60.36	0.182	-0.059	4980.4	500.00	3.00	4.46	37.59	1.90	2.32	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0122	60.85	0.183	-0.061	4980.4	500.00	1.99	4.46	41.74	1.23	1.56	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0123	61.35	0.185	-0.062	4980.3	500.00	0.96	4.46	44.99	0.55	0.76	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0124	61.85	0.186	-0.064	4980.3	500.00	0.06	4.46	178.32	-0.06	-0.09	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0125	62.35	0.188	-0.065	4980.3	500.00	0.95	4.46	225.53	-0.65	-0.70	-55.	-57.	2326.	-2323.	-0.	0.	1.
0.0126	62.85	0.189	-0.067	4980.3	500.00	1.73	4.46	229.81	-1.14	-1.29	-55.	-57.	2326.	-2324.	-0.	0.	1.
0.0127	63.35	0.190	-0.068	4980.3	500.00	2.33	4.46	233.39	-1.52	-1.76	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0128	63.84	0.192	-0.069	4980.2	500.00	2.72	4.46	236.95	-1.75	-2.09	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0129	64.34	0.193	-0.071	4980.2	500.00	2.89	4.46	240.64	-1.83	-2.24	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0130	64.84	0.194	-0.072	4980.1	500.00	2.86	4.46	244.73	-1.75	-2.24	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0131	65.34	0.195	-0.073	4980.0	500.00	2.57	4.46	249.46	-1.51	-2.07	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0132	65.84	0.196	-0.074	4980.0	500.00	2.10	4.46	255.70	-1.13	-1.76	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0133	66.33	0.197	-0.074	4980.0	500.00	1.47	4.46	265.87	-0.63	-1.33	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0134	66.83	0.197	-0.075	4979.9	500.00	0.80	4.46	291.69	-0.03	-0.80	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0135	67.33	0.198	-0.076	4979.9	500.00	0.66	4.46	8.67	0.53	-0.21	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0136	67.83	0.199	-0.077	4979.9	500.00	1.38	4.46	47.20	1.32	0.41	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0137	68.33	0.200	-0.077	4979.9	500.00	2.25	4.46	59.73	2.01	1.02	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0138	68.82	0.201	-0.078	4979.9	500.00	3.05	4.46	66.50	2.65	1.59	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0139	69.32	0.202	-0.079	4979.8	500.00	3.82	4.46	71.23	3.22	2.07	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0140	69.82	0.203	-0.080	4979.7	500.00	4.42	4.46	74.95	3.68	2.45	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0141	70.32	0.204	-0.081	4979.6	500.00	4.83	4.46	78.05	4.01	2.67	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0142	70.82	0.205	-0.082	4979.4	500.00	5.05	4.46	81.63	4.20	2.79	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0143	71.31	0.207	-0.083	4979.3	500.00	5.05	4.46	92.75	4.24	2.74	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0144	71.81	0.208	-0.085	4979.1	500.00	4.84	4.46	84.31	4.13	2.53	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0145	72.31	0.210	-0.086	4979.0	500.00	4.47	4.46	85.10	3.86	2.18	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0146	72.81	0.212	-0.088	4978.9	500.00	3.86	4.46	84.67	3.47	1.70	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0147	73.30	0.214	-0.089	4978.8	500.00	3.17	4.46	82.13	2.97	1.12	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0148	73.80	0.216	-0.091	4978.7	500.00	2.42	4.46	75.36	2.33	0.47	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0149	74.30	0.218	-0.092	4978.7	500.00	1.76	4.46	59.52	1.74	-0.23	-55.	-57.	2327.	-2324.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA~ DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.0150	74.80	0.221	-0.104	4978.7	500.00	1.43	4.46	29.30	1.09	-0.04	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0151	75.30	0.223	-0.096	4978.7	500.00	1.67	4.46	359.37	0.45	-1.61	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0152	75.79	0.225	-0.097	4978.7	500.00	2.24	4.46	342.06	-0.15	-2.23	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0153	76.29	0.227	-0.099	4978.6	500.00	2.94	4.46	335.23	-0.66	-2.75	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0154	76.79	0.230	-0.100	4978.5	500.00	3.35	4.46	332.91	-1.07	-3.13	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0155	77.29	0.232	-0.101	4978.5	500.00	3.72	4.46	332.96	-1.34	-3.46	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0156	77.79	0.234	-0.102	4978.4	500.00	3.92	4.46	334.44	-1.52	-3.61	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0157	78.28	0.236	-0.104	4978.3	500.00	3.92	4.46	337.93	-1.54	-3.61	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0158	78.78	0.238	-0.105	4978.2	500.00	3.75	4.46	340.66	-1.42	-3.47	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0159	79.28	0.240	-0.105	4978.1	500.00	3.41	4.46	345.52	-1.18	-3.20	-55.	-57.	2327.	-2324.	-0.	0.	1.
0.0160	79.78	0.241	-0.106	4978.0	500.00	2.97	4.46	352.15	-0.94	-2.81	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0161	80.27	0.243	-0.107	4978.0	500.00	2.38	4.46	1.77	-0.41	-2.35	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0162	80.77	0.245	-0.107	4978.0	500.00	1.92	4.46	17.07	0.03	-1.82	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0163	81.27	0.247	-0.108	4978.0	500.00	1.40	4.46	42.70	0.63	-1.26	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0164	81.77	0.248	-0.108	4977.9	500.00	1.32	4.46	77.49	1.11	-0.71	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0165	82.27	0.250	-0.109	4977.9	500.00	1.61	4.46	105.69	1.59	-0.20	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0166	82.76	0.252	-0.109	4977.9	500.00	2.03	4.46	123.02	2.01	0.25	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0167	83.26	0.254	-0.109	4977.9	500.00	2.42	4.46	133.46	2.34	0.62	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0168	83.76	0.256	-0.110	4977.8	500.00	2.70	4.46	140.35	2.54	0.87	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0169	84.26	0.258	-0.111	4977.8	500.00	2.84	4.46	145.12	2.65	1.00	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0170	84.75	0.260	-0.111	4977.7	500.00	2.81	4.46	143.30	2.62	1.01	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0171	85.25	0.262	-0.112	4977.7	500.00	2.61	4.46	149.93	2.46	0.88	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0172	85.75	0.265	-0.113	4977.6	500.00	2.27	4.46	149.46	2.17	0.64	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0173	86.25	0.267	-0.113	4977.6	500.00	1.80	4.46	145.25	1.78	0.29	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0174	86.75	0.270	-0.114	4977.6	500.00	1.29	4.46	132.47	1.25	-0.14	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0175	87.24	0.272	-0.115	4977.6	500.00	0.97	4.46	103.43	0.73	-0.64	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0176	87.74	0.275	-0.116	4977.6	500.00	1.17	4.46	60.77	0.13	-1.17	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0177	88.24	0.277	-0.117	4977.6	500.00	1.77	4.46	41.46	-0.49	-1.70	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0178	88.74	0.280	-0.117	4977.5	500.00	2.46	4.46	34.17	-1.09	-2.21	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0179	89.23	0.282	-0.118	4977.5	500.00	3.13	4.46	31.62	-1.65	-2.67	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0180	89.73	0.285	-0.118	4977.4	500.00	3.71	4.46	31.19	-2.12	-3.04	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0181	90.23	0.287	-0.119	4977.3	500.00	4.16	4.46	31.95	-2.51	-3.32	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0182	90.73	0.290	-0.119	4977.2	500.00	4.47	4.46	33.12	-2.79	-3.49	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0183	91.22	0.292	-0.120	4977.1	500.00	4.60	4.46	34.73	-2.95	-3.53	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0184	91.72	0.294	-0.120	4977.0	500.00	4.56	4.46	36.55	-2.97	-3.45	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0185	92.22	0.296	-0.120	4976.8	500.00	4.34	4.46	38.47	-2.91	-3.24	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0186	92.72	0.298	-0.120	4976.7	500.00	3.99	4.46	40.39	-2.72	-2.93	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0187	93.22	0.300	-0.119	4976.6	500.00	3.50	4.46	42.15	-2.42	-2.52	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0188	93.71	0.302	-0.119	4976.6	500.00	2.89	4.46	43.51	-2.03	-2.03	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0189	94.21	0.303	-0.119	4976.5	500.00	2.21	4.46	44.31	-1.53	-1.50	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0190	94.71	0.305	-0.118	4976.5	500.00	1.51	4.46	43.11	-1.18	-0.94	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0191	95.21	0.307	-0.118	4976.5	500.00	0.82	4.46	35.22	-0.73	-0.38	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0192	95.70	0.308	-0.118	4976.5	500.00	0.33	4.46	344.42	-0.30	0.14	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0193	96.20	0.310	-0.117	4976.5	500.00	0.62	4.46	275.52	0.08	0.61	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0194	96.70	0.311	-0.117	4976.5	500.00	1.08	4.46	264.36	0.39	1.01	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0195	97.20	0.313	-0.117	4976.5	500.00	1.44	4.45	253.91	0.61	1.30	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0196	97.69	0.315	-0.116	4976.5	500.00	1.66	4.46	265.53	0.73	1.50	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0197	98.19	0.316	-0.116	4976.4	500.00	1.74	4.46	269.70	0.76	1.58	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0198	98.69	0.318	-0.116	4976.4	500.00	1.67	4.46	275.24	0.64	1.55	-55.	-57.	2326.	-2325.	-0.	0.	1.
0.0199	99.19	0.320	-0.116	4976.4	500.00	1.48	4.46	283.44	0.43	1.41	-55.	-57.	2326.	-2325.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	$\overline{\text{ALPHA}}$ DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T SEG
0.0200	99.68	0.322	-0.116	4976.4	500.00	1.19	4.46	256.78	0.14	1.18	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0201	100.18	0.324	-0.115	4976.4	500.00	0.91	4.46	321.29	-0.24	0.88	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0202	100.68	0.326	-0.116	4976.4	500.00	0.85	4.46	0.91	-0.67	0.52	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0203	101.18	0.328	-0.116	4976.4	500.00	1.14	4.46	35.16	-1.13	0.13	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0204	101.68	0.329	-0.116	4976.4	500.00	1.62	4.46	54.07	-1.63	-0.26	-55.	-57.	2329.	-2325.	-0.	0.	1.
0.0205	102.17	0.331	-0.116	4976.3	500.00	2.15	4.46	64.94	-2.05	-0.64	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0206	102.67	0.333	-0.117	4976.3	500.00	2.65	4.46	72.07	-2.47	-0.98	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0207	103.17	0.335	-0.117	4976.3	500.00	3.09	4.46	77.25	-2.82	-1.25	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0208	103.67	0.336	-0.117	4976.2	500.00	3.41	4.46	81.22	-3.04	-1.44	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0209	104.16	0.338	-0.117	4976.1	500.00	3.60	4.46	84.32	-3.26	-1.54	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0210	104.65	0.339	-0.116	4976.0	500.00	3.66	4.45	86.67	-3.33	-1.53	-55.	-57.	2329.	-2325.	-0.	0.	1.
0.0211	105.16	0.340	-0.115	4975.9	500.00	3.58	4.46	88.23	-3.29	-1.42	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0212	105.66	0.342	-0.115	4975.9	500.00	3.37	4.45	89.82	-3.14	-1.21	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0213	106.15	0.343	-0.115	4975.8	500.00	3.04	4.46	88.05	-2.90	-0.91	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0214	106.65	0.344	-0.115	4975.8	500.00	2.62	4.46	85.21	-2.55	-0.53	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0215	107.15	0.344	-0.115	4975.7	500.00	2.17	4.44	78.06	-2.15	-0.10	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0216	107.65	0.345	-0.115	4975.7	500.00	1.76	4.45	65.53	-1.72	0.38	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0217	108.14	0.346	-0.114	4975.7	500.00	1.52	4.46	46.93	-1.24	0.67	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0218	108.64	0.347	-0.113	4975.7	500.00	1.56	4.46	24.29	-0.76	1.36	-55.	-57.	2328.	-2326.	-0.	0.	1.
0.0219	109.14	0.347	-0.113	4975.7	500.00	1.94	4.46	7.43	-0.31	1.81	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0220	109.64	0.349	-0.113	4975.6	500.00	2.22	4.46	357.92	0.11	2.21	-55.	-57.	2328.	-2326.	-0.	0.	1.
0.0221	110.13	0.349	-0.113	4975.6	500.00	2.59	4.46	353.33	0.45	2.55	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0222	110.63	0.350	-0.113	4975.6	500.00	2.89	4.46	351.70	0.73	2.79	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0223	111.13	0.351	-0.113	4975.5	500.00	3.09	4.46	351.93	0.92	2.95	-55.	-57.	2329.	-2324.	-0.	0.	1.
0.0224	111.63	0.351	-0.113	4975.4	500.00	3.16	4.45	353.49	1.01	3.10	-55.	-57.	2329.	-2326.	-0.	0.	1.
0.0225	112.12	0.352	-0.113	4975.4	500.00	3.12	4.46	355.14	1.11	2.95	-55.	-57.	2329.	-2325.	-0.	0.	1.
0.0226	112.62	0.353	-0.113	4975.3	500.00	2.96	4.46	359.85	0.92	2.81	-55.	-57.	2329.	-2325.	-0.	0.	1.
0.0227	113.12	0.354	-0.114	4975.3	500.00	2.69	4.46	4.30	0.74	2.59	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0228	113.62	0.355	-0.114	4975.2	500.00	2.35	4.45	11.42	0.50	2.30	-55.	-57.	2329.	-2326.	-0.	0.	1.
0.0229	114.11	0.355	-0.115	4975.2	500.00	1.96	4.46	20.58	0.20	1.95	-55.	-57.	2328.	-2326.	-0.	0.	1.
0.0230	114.61	0.357	-0.115	4975.2	500.00	1.58	4.46	33.93	-0.12	1.58	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0231	115.11	0.358	-0.116	4975.2	500.00	1.29	4.45	53.20	-0.45	1.20	-55.	-57.	2328.	-2326.	-0.	0.	1.
0.0232	115.61	0.360	-0.117	4975.2	500.00	1.14	4.46	78.51	-0.78	0.83	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0233	116.10	0.361	-0.117	4975.2	500.00	1.18	4.46	103.44	-1.07	0.49	-55.	-57.	2329.	-2325.	-0.	0.	1.
0.0234	116.60	0.362	-0.118	4975.1	500.00	1.33	4.46	122.12	-1.31	0.20	-55.	-57.	2329.	-2324.	-0.	0.	1.
0.0235	117.10	0.362	-0.119	4975.1	500.00	1.48	4.46	134.36	-1.43	-0.02	-55.	-57.	2229.	-2326.	-0.	0.	1.
0.0236	117.60	0.363	-0.119	4975.1	500.00	1.56	4.46	142.33	-1.57	-0.16	-55.	-57.	2329.	-2326.	-0.	0.	1.
0.0237	118.09	0.364	-0.120	4975.1	500.00	1.59	4.46	147.25	-1.59	-0.22	-55.	-57.	2328.	-2325.	-0.	0.	1.
0.0238	118.59	0.365	-0.120	4975.1	500.00	1.50	4.46	149.52	-1.49	-0.19	-55.	-57.	2328.	-2326.	-0.	0.	1.
0.0239	119.09	0.366	-0.121	4975.1	500.00	1.32	4.46	148.56	-1.32	-0.03	-55.	-57.	2328.	-2326.	-0.	0.	1.
0.0240	119.59	0.366	-0.121	4975.0	500.00	1.05	4.45	142.14	-1.05	0.11	-55.	-57.	2329.	-2326.	-0.	0.	1.
0.0241	120.08	0.367	-0.122	4975.0	500.00	0.82	4.46	124.65	-0.73	0.36	-55.	-57.	2329.	-2326.	-0.	0.	1.
0.0242	120.58	0.367	-0.122	4975.0	500.00	0.75	4.46	91.49	-0.35	0.66	-55.	-57.	2329.	-2326.	-0.	0.	1.
0.0243	121.08	0.368	-0.123	4975.0	500.00	1.00	4.45	62.40	0.07	0.99	-55.	-57.	2329.	-2325.	-0.	0.	1.
0.0244	121.58	0.369	-0.123	4975.0	500.00	1.43	4.46	48.35	0.51	1.34	-55.	-57.	2329.	-2326.	-0.	0.	1.
0.0245	122.07	0.369	-0.124	4975.0	500.00	1.92	4.45	42.57	0.95	1.57	-55.	-57.	2328.	-2326.	-0.	0.	1.
0.0246	122.57	0.370	-0.125	4975.0	500.00	2.41	4.46	40.44	1.47	1.98	-55.	-57.	2329.	-2326.	-0.	0.	1.
0.0247	123.07	0.370	-0.125	4974.9	500.00	2.84	4.46	40.07	1.75	2.24	-55.	-57.	2329.	-2326.	-0.	0.	1.
0.0248	123.57	0.371	-0.126	4974.9	500.00	3.20	4.46	40.53	2.07	2.44	-55.	-57.	2329.	-2325.	-0.	0.	1.
0.0249	124.06	0.372	-0.127	4974.8	500.00	3.46	4.45	41.72	2.32	2.57	-55.	-57.	2329.	-2325.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T FIG
0.0250	124.56	0.373	-0.128	4974.7	500.00	3.61	4.46	63.09	2.73	2.51	-55.	-57.	2323.	-2324.	-0.	0.	1.
0.0251	125.06	0.374	-0.129	4974.7	500.00	3.64	4.45	64.57	2.57	2.57	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0252	125.56	0.375	-0.130	4974.6	500.00	3.54	4.45	65.05	2.55	2.45	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0253	126.05	0.376	-0.131	4974.5	500.00	3.34	4.46	67.41	2.43	2.24	-55.	-57.	2329.	-2326.	-0.	0.	1.
0.0254	126.55	0.377	-0.132	4974.5	500.00	3.06	4.45	63.46	2.31	1.97	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0255	127.05	0.378	-0.134	4974.4	500.00	2.65	4.46	59.93	2.09	1.63	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0256	127.55	0.379	-0.135	4974.4	500.00	2.21	4.45	55.51	1.92	1.26	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0257	128.04	0.381	-0.136	4974.4	500.00	1.74	4.46	46.17	1.51	0.85	-55.	-57.	2327.	-2325.	-0.	0.	1.
0.0258	128.54	0.382	-0.137	4974.3	500.00	1.29	4.46	40.05	1.13	0.45	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0259	129.04	0.384	-0.137	4974.3	500.00	0.89	4.46	25.73	0.83	0.15	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0260	129.54	0.385	-0.141	4974.3	500.00	0.68	4.46	357.49	0.50	-0.32	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0261	130.03	0.386	-0.142	4974.3	500.00	0.73	4.46	327.17	0.33	-0.63	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0262	130.53	0.388	-0.143	4974.3	500.00	0.91	4.46	311.22	0.16	-0.90	-55.	-57.	2323.	-2325.	-0.	0.	1.
0.0263	131.03	0.389	-0.145	4974.3	500.00	1.09	4.46	305.75	0.04	-1.09	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0264	131.53	0.391	-0.146	4974.3	500.00	1.21	4.46	303.83	-0.02	-1.23	-55.	-57.	2327.	-2326.	-0.	0.	1.
0.0265	132.02	0.392	-0.147	4974.3	500.00	1.25	4.46	309.76	0.00	-1.25	-55.	-57.	2324.	-2326.	-0.	0.	1.
0.0266	132.52	0.394	-0.148	4974.3	500.00	1.22	4.46	317.09	0.12	-1.21	-55.	-57.	2323.	-2325.	-0.	0.	1.
0.0267	133.02	0.395	-0.150	4974.3	500.00	1.14	4.46	328.30	0.26	-1.11	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0268	133.52	0.396	-0.151	4974.3	500.00	1.07	4.46	344.57	0.45	-0.95	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0269	134.01	0.398	-0.152	4974.3	500.00	1.06	4.46	6.03	0.75	-0.73	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0270	134.51	0.399	-0.153	4974.3	500.00	1.14	4.46	27.57	1.05	-0.51	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0271	135.01	0.400	-0.154	4974.2	500.00	1.38	4.46	45.53	1.35	-0.27	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0272	135.51	0.402	-0.155	4974.2	500.00	1.66	4.46	58.93	1.65	-0.02	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0273	136.00	0.403	-0.156	4974.2	500.00	1.96	4.46	69.35	1.95	0.20	-55.	-57.	2329.	-2326.	-0.	0.	1.
0.0274	136.50	0.405	-0.157	4974.2	500.00	2.23	4.46	75.35	2.20	0.37	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0275	137.00	0.406	-0.158	4974.2	500.00	2.45	4.46	80.50	2.40	0.52	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0276	137.49	0.408	-0.159	4974.1	500.00	2.60	4.46	84.53	2.53	0.60	-55.	-57.	2323.	-2325.	-0.	0.	1.
0.0277	137.99	0.410	-0.160	4974.1	500.00	2.67	4.46	87.35	2.60	0.62	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0278	138.49	0.412	-0.161	4974.0	500.00	2.64	4.46	89.09	2.59	0.56	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0279	138.99	0.414	-0.162	4974.0	500.00	2.54	4.46	89.60	2.50	0.44	-55.	-57.	2323.	-2325.	-0.	0.	1.
0.0280	139.48	0.416	-0.164	4974.0	500.00	2.35	4.46	88.59	2.34	0.25	-55.	-57.	2327.	-2326.	-0.	0.	1.
0.0281	139.98	0.418	-0.165	4973.9	500.00	2.12	4.46	85.46	2.12	0.00	-55.	-57.	2327.	-2325.	-0.	0.	1.
0.0282	140.48	0.420	-0.166	4973.9	500.00	1.86	4.46	79.33	1.84	-0.29	-55.	-57.	2327.	-2326.	-0.	0.	1.
0.0283	140.98	0.422	-0.167	4973.9	500.00	1.64	4.46	69.15	1.52	-0.61	-55.	-57.	2323.	-2323.	-0.	0.	1.
0.0284	141.47	0.424	-0.169	4973.9	500.00	1.51	4.46	54.54	1.17	-0.95	-55.	-57.	2323.	-2325.	-0.	0.	1.
0.0285	141.97	0.426	-0.170	4973.9	500.00	1.53	4.46	38.48	0.81	-1.30	-55.	-57.	2323.	-2325.	-0.	0.	1.
0.0286	142.47	0.429	-0.171	4973.9	500.00	1.69	4.46	25.59	0.45	-1.52	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0287	142.97	0.431	-0.172	4973.8	500.00	1.92	4.46	16.49	0.13	-1.92	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0288	143.46	0.433	-0.173	4973.8	500.00	2.18	4.46	11.15	-0.17	-2.17	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0289	143.96	0.436	-0.174	4973.8	500.00	2.40	4.46	8.57	-0.41	-2.37	-55.	-57.	2323.	-2325.	-0.	0.	1.
0.0290	144.46	0.438	-0.175	4973.7	500.00	2.57	4.46	7.77	-0.59	-2.50	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0291	144.96	0.440	-0.176	4973.7	500.00	2.67	4.46	8.37	-0.73	-2.57	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0292	145.45	0.442	-0.177	4973.7	500.00	2.68	4.45	10.03	-0.78	-2.56	-55.	-57.	2323.	-2326.	-0.	0.	1.
0.0293	145.95	0.444	-0.177	4973.6	500.00	2.61	4.45	12.40	-0.78	-2.49	-55.	-57.	2327.	-2326.	-0.	0.	1.
0.0294	146.45	0.447	-0.178	4973.6	500.00	2.47	4.45	16.07	-0.71	-2.36	-55.	-57.	2328.	-2327.	-0.	0.	1.
0.0295	146.94	0.449	-0.178	4973.6	500.00	2.26	4.45	20.53	-0.59	-2.18	-55.	-57.	2331.	-2327.	-0.	0.	1.
0.0296	147.44	0.451	-0.179	4973.5	500.00	2.00	4.45	25.22	-0.42	-1.97	-55.	-57.	2333.	-2327.	-0.	0.	1.
0.0297	147.94	0.453	-0.179	4973.5	500.00	1.71	4.45	33.57	-0.23	-1.70	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0298	148.44	0.455	-0.180	4973.5	500.00	1.43	4.45	43.23	-0.02	-1.43	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0299	148.93	0.457	-0.180	4973.5	500.00	1.17	4.45	56.83	0.19	-1.16	-55.	-57.	2330.	-2327.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.0300	149.43	0.459	-0.180	4973.5	500.00	0.98	4.45	72.45	0.34	-0.90	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0301	149.93	0.461	-0.181	4973.5	500.00	0.87	4.45	91.23	0.54	-0.68	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0302	150.43	0.463	-0.181	4973.5	500.00	0.82	4.45	109.99	0.66	-0.49	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0303	150.92	0.465	-0.181	4973.5	500.00	0.81	4.45	122.72	0.73	-0.35	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0304	151.42	0.467	-0.182	4973.5	500.00	0.80	4.45	131.46	0.75	-0.27	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0305	151.92	0.469	-0.182	4973.4	500.00	0.76	4.45	134.97	0.70	-0.25	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0306	152.42	0.472	-0.182	4973.4	500.00	0.65	4.45	132.12	0.57	-0.29	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0307	152.91	0.474	-0.182	4973.4	500.00	0.56	4.45	119.69	0.43	-0.35	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0308	153.41	0.476	-0.183	4973.4	500.00	0.53	4.45	95.58	0.21	-0.49	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0309	153.91	0.478	-0.183	4973.4	500.00	0.66	4.45	70.81	-0.05	-0.65	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0310	154.40	0.481	-0.183	4973.4	500.00	0.93	4.45	56.24	-0.35	-0.86	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0311	154.90	0.483	-0.184	4973.4	500.00	1.25	4.45	49.42	-0.57	-1.06	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0312	155.40	0.485	-0.184	4973.4	500.00	1.61	4.45	45.55	-0.93	-1.27	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0313	155.90	0.487	-0.185	4973.4	500.00	1.96	4.45	45.74	-1.23	-1.47	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0314	156.39	0.490	-0.184	4973.4	500.00	2.27	4.45	46.12	-1.53	-1.64	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0315	156.89	0.492	-0.184	4973.3	500.00	2.54	4.45	46.95	-1.83	-1.77	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0316	157.39	0.494	-0.184	4973.3	500.00	2.75	4.45	48.02	-2.04	-1.85	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0317	157.89	0.496	-0.184	4973.2	500.00	2.89	4.45	49.32	-2.19	-1.88	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0318	158.38	0.498	-0.184	4973.2	500.00	2.94	4.45	50.62	-2.28	-1.85	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0319	158.88	0.500	-0.184	4973.1	500.00	2.91	4.45	51.80	-2.31	-1.77	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0320	159.38	0.502	-0.184	4973.1	500.00	2.80	4.45	52.73	-2.23	-1.63	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0321	159.88	0.503	-0.184	4973.1	500.00	2.62	4.45	53.25	-2.10	-1.43	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0322	160.37	0.505	-0.184	4973.0	500.00	2.39	4.45	53.12	-2.06	-1.19	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0323	160.87	0.507	-0.183	4973.0	500.00	2.09	4.45	52.00	-1.88	-0.92	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0324	161.37	0.509	-0.183	4973.0	500.00	1.79	4.45	49.33	-1.67	-0.63	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0325	161.86	0.510	-0.183	4973.0	500.00	1.49	4.45	44.26	-1.45	-0.33	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0326	162.36	0.511	-0.182	4972.9	500.00	1.23	4.45	35.66	-1.23	-0.03	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0327	162.86	0.513	-0.182	4972.9	500.00	1.04	4.45	22.92	-1.01	0.26	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0328	163.36	0.514	-0.182	4972.9	500.00	0.97	4.45	7.77	-0.81	0.52	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0329	163.85	0.515	-0.181	4972.9	500.00	0.99	4.45	354.43	-0.65	0.74	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0330	164.35	0.517	-0.181	4972.9	500.00	1.06	4.45	345.97	-0.53	0.92	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0331	164.85	0.519	-0.181	4972.9	500.00	1.14	4.45	342.33	-0.45	1.04	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0332	165.35	0.520	-0.181	4972.9	500.00	1.20	4.45	342.67	-0.43	1.12	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0333	165.84	0.521	-0.180	4972.9	500.00	1.23	4.45	346.27	-0.45	1.14	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0334	166.34	0.523	-0.180	4972.9	500.00	1.23	4.45	352.77	-0.53	1.11	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0335	166.84	0.524	-0.180	4972.9	500.00	1.23	4.45	2.00	-0.67	1.04	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0336	167.33	0.525	-0.180	4972.9	500.00	1.23	4.45	13.51	-0.80	0.94	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0337	167.83	0.527	-0.180	4972.9	500.00	1.27	4.45	26.43	-0.98	0.81	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0338	168.33	0.528	-0.180	4972.8	500.00	1.34	4.45	39.42	-1.17	0.66	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0339	168.83	0.529	-0.180	4972.8	500.00	1.45	4.45	51.25	-1.36	0.51	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0340	169.32	0.531	-0.180	4972.8	500.00	1.59	4.45	61.27	-1.55	0.37	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0341	169.82	0.532	-0.180	4972.8	500.00	1.73	4.45	69.38	-1.72	0.24	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0342	170.32	0.533	-0.180	4972.8	500.00	1.86	4.45	75.74	-1.85	0.15	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0343	170.82	0.534	-0.180	4972.8	500.00	1.95	4.45	80.57	-1.92	0.09	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0344	171.31	0.536	-0.180	4972.8	500.00	1.99	4.45	84.00	-1.93	0.07	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0345	171.81	0.537	-0.180	4972.7	500.00	1.99	4.45	86.06	-1.97	0.10	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0346	172.31	0.538	-0.180	4972.7	500.00	1.93	4.45	86.67	-1.93	0.17	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0347	172.80	0.539	-0.180	4972.7	500.00	1.84	4.45	85.67	-1.82	0.29	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0348	173.30	0.539	-0.180	4972.7	500.00	1.72	4.45	82.40	-1.66	0.45	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0349	173.80	0.540	-0.180	4972.6	500.00	1.59	4.45	75.71	-1.45	0.66	-55.	-57.	2330.	-2327.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.0350	174.30	0.541	-0.180	4972.6	500.00	1.49	4.45	63.23	-1.22	0.85	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0351	174.79	0.542	-0.180	4972.6	500.00	1.45	4.45	57.67	-0.95	1.08	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0352	175.29	0.542	-0.180	4972.6	500.00	1.48	4.45	45.54	-0.69	1.32	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0353	175.79	0.543	-0.180	4972.6	500.00	1.60	4.45	35.31	-0.41	1.54	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0354	176.28	0.544	-0.180	4972.6	500.00	1.76	4.45	28.54	-0.15	1.75	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0355	176.78	0.544	-0.180	4972.6	500.00	1.94	4.45	24.74	0.11	1.94	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0356	177.28	0.545	-0.181	4972.5	500.00	2.11	4.45	21.99	0.31	2.03	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0357	177.78	0.546	-0.181	4972.5	500.00	2.24	4.45	20.77	0.49	2.19	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0358	178.27	0.546	-0.181	4972.5	500.00	2.33	4.45	20.74	0.62	2.25	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0359	178.77	0.547	-0.182	4972.5	500.00	2.37	4.45	21.62	0.71	2.26	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0360	179.27	0.548	-0.182	4972.4	500.00	2.35	4.45	23.25	0.75	2.22	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0361	179.77	0.549	-0.183	4972.4	500.00	2.27	4.45	25.53	0.75	2.14	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0362	180.26	0.550	-0.183	4972.4	500.00	2.14	4.45	28.41	0.70	2.02	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0363	180.76	0.551	-0.184	4972.3	500.00	1.97	4.45	31.91	0.63	1.85	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0364	181.26	0.551	-0.185	4972.3	500.00	1.76	4.45	36.09	0.52	1.58	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0365	181.75	0.552	-0.185	4972.3	500.00	1.54	4.45	41.00	0.41	1.49	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0366	182.25	0.553	-0.186	4972.3	500.00	1.32	4.45	46.81	0.28	1.29	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0367	182.75	0.554	-0.187	4972.3	500.00	1.11	4.45	53.61	0.16	1.09	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0368	183.25	0.555	-0.188	4972.3	500.00	0.91	4.45	61.39	0.05	0.91	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0369	183.74	0.556	-0.189	4972.3	500.00	0.76	4.45	69.79	-0.03	0.75	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0370	184.24	0.557	-0.190	4972.3	500.00	0.63	4.45	77.76	-0.08	0.63	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0371	184.74	0.558	-0.191	4972.3	500.00	0.54	4.45	83.41	-0.07	0.53	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0372	185.24	0.559	-0.191	4972.3	500.00	0.48	4.45	84.39	-0.07	0.47	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0373	185.73	0.560	-0.192	4972.3	500.00	0.44	4.45	79.11	0.00	0.46	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0374	186.23	0.560	-0.193	4972.3	500.00	0.49	4.45	69.03	0.11	0.47	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0375	186.73	0.561	-0.194	4972.3	500.00	0.59	4.45	59.00	0.26	0.53	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0376	187.22	0.562	-0.195	4972.3	500.00	0.75	4.45	53.14	0.43	0.61	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0377	187.72	0.563	-0.196	4972.3	500.00	0.95	4.45	48.54	0.64	0.71	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0378	188.22	0.564	-0.197	4972.3	500.00	1.19	4.45	47.16	0.85	0.82	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0379	188.72	0.565	-0.198	4972.2	500.00	1.43	4.45	47.12	1.07	0.96	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0380	189.21	0.566	-0.199	4972.2	500.00	1.69	4.45	47.85	1.31	1.05	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0381	189.71	0.567	-0.200	4972.2	500.00	1.90	4.45	49.01	1.52	1.14	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0382	190.21	0.568	-0.201	4972.2	500.00	2.10	4.45	50.35	1.71	1.22	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0383	190.70	0.569	-0.202	4972.2	500.00	2.26	4.45	51.91	1.87	1.26	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0384	191.20	0.570	-0.203	4972.1	500.00	2.37	4.45	53.20	2.00	1.27	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0385	191.70	0.571	-0.204	4972.1	500.00	2.42	4.45	54.45	2.10	1.23	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0386	192.20	0.572	-0.206	4972.1	500.00	2.42	4.45	55.47	2.12	1.13	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0387	192.69	0.573	-0.207	4972.0	500.00	2.37	4.45	56.13	2.11	1.07	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0388	193.19	0.575	-0.208	4972.0	500.00	2.27	4.45	56.30	2.07	0.93	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0389	193.69	0.576	-0.209	4972.0	500.00	2.12	4.45	55.78	1.95	0.75	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0390	194.19	0.578	-0.211	4972.0	500.00	1.94	4.45	54.34	1.86	0.55	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0391	194.69	0.579	-0.212	4971.9	500.00	1.75	4.45	51.65	1.72	0.33	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0392	195.18	0.581	-0.213	4971.9	500.00	1.56	4.45	47.36	1.55	0.10	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0393	195.68	0.582	-0.215	4971.9	500.00	1.40	4.45	41.22	1.39	-0.13	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0394	196.17	0.584	-0.216	4971.9	500.00	1.27	4.45	33.35	1.23	-0.35	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0395	196.67	0.586	-0.217	4971.9	500.00	1.21	4.45	24.59	1.07	-0.56	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0396	197.17	0.587	-0.219	4971.9	500.00	1.19	4.45	15.38	0.93	-0.74	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0397	197.67	0.589	-0.220	4971.9	500.00	1.21	4.45	10.06	0.81	-0.90	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0398	198.16	0.591	-0.221	4971.9	500.00	1.25	4.45	6.27	0.73	-1.02	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0399	198.66	0.592	-0.223	4971.9	500.00	1.30	4.45	5.03	0.69	-1.11	-55.	-57.	2330.	-2327.	-0.	0.	1.

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T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	$\bar{\text{ALPHA}}$ DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.0400	199.16	0.594	-0.224	4971.9	500.00	1.33	4.45	6.11	0.66	-1.16	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0401	199.65	0.596	-0.225	4971.8	500.00	1.35	4.45	9.25	0.67	-1.17	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0402	200.15	0.598	-0.226	4971.9	500.00	1.36	4.45	14.20	0.72	-1.15	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0403	200.65	0.599	-0.227	4971.8	500.00	1.36	4.45	20.69	0.77	-1.11	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0404	201.15	0.601	-0.228	4971.8	500.00	1.37	4.45	28.41	0.89	-1.04	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0405	201.64	0.603	-0.229	4971.8	500.00	1.38	4.45	36.68	0.99	-0.95	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0406	202.14	0.605	-0.230	4971.8	500.00	1.41	4.45	45.55	1.11	-0.87	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0407	202.64	0.607	-0.231	4971.8	500.00	1.44	4.45	53.96	1.22	-0.78	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0408	203.13	0.609	-0.232	4971.8	500.00	1.49	4.45	61.37	1.31	-0.70	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0409	203.63	0.610	-0.233	4971.7	500.00	1.53	4.45	67.77	1.39	-0.64	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0410	204.13	0.612	-0.234	4971.7	500.00	1.56	4.45	72.91	1.43	-0.59	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0411	204.63	0.614	-0.235	4971.7	500.00	1.58	4.45	76.69	1.47	-0.57	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0412	205.12	0.616	-0.236	4971.7	500.00	1.57	4.45	77.04	1.46	-0.58	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0413	205.62	0.619	-0.237	4971.7	500.00	1.54	4.45	79.33	1.41	-0.63	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0414	206.12	0.621	-0.238	4971.7	500.00	1.50	4.45	78.92	1.32	-0.70	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0415	206.61	0.623	-0.239	4971.7	500.00	1.44	4.45	76.13	1.20	-0.79	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0416	207.11	0.625	-0.240	4971.7	500.00	1.39	4.45	71.33	1.05	-0.91	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0417	207.61	0.627	-0.241	4971.6	500.00	1.37	4.45	64.92	0.87	-1.05	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0418	208.11	0.630	-0.241	4971.6	500.00	1.38	4.45	57.37	0.67	-1.20	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0419	208.60	0.632	-0.242	4971.6	500.00	1.43	4.45	43.78	0.46	-1.36	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0420	209.10	0.634	-0.243	4971.6	500.00	1.53	4.45	43.09	0.25	-1.51	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0421	209.60	0.637	-0.244	4971.6	500.00	1.65	4.45	37.63	0.03	-1.65	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0422	210.09	0.639	-0.244	4971.6	500.00	1.76	4.45	34.12	-0.17	-1.77	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0423	210.59	0.641	-0.245	4971.6	500.00	1.91	4.45	31.79	-0.35	-1.88	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0424	211.09	0.643	-0.246	4971.5	500.00	2.02	4.45	30.57	-0.51	-1.95	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0425	211.59	0.646	-0.246	4971.5	500.00	2.09	4.45	30.27	-0.64	-1.99	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0426	212.08	0.648	-0.247	4971.5	500.00	2.13	4.45	30.57	-0.74	-2.00	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0427	212.58	0.650	-0.247	4971.5	500.00	2.13	4.45	31.43	-0.81	-1.98	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0428	213.08	0.652	-0.247	4971.4	500.00	2.09	4.45	33.05	-0.89	-1.92	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0429	213.57	0.655	-0.248	4971.4	500.00	2.02	4.45	34.32	-0.95	-1.83	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0430	214.07	0.657	-0.248	4971.4	500.00	1.90	4.45	35.89	-0.92	-1.72	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0431	214.57	0.659	-0.248	4971.4	500.00	1.76	4.45	37.18	-0.79	-1.58	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0432	215.07	0.661	-0.249	4971.4	500.00	1.60	4.45	41.65	-0.72	-1.43	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0433	215.56	0.663	-0.249	4971.4	500.00	1.43	4.45	44.19	-0.65	-1.28	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0434	216.06	0.665	-0.249	4971.3	500.00	1.24	4.45	46.69	-0.58	-1.12	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0435	216.56	0.667	-0.249	4971.3	500.00	1.10	4.45	48.97	-0.51	-0.97	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0436	217.05	0.669	-0.249	4971.3	500.00	0.95	4.45	50.75	-0.46	-0.83	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0437	217.55	0.671	-0.249	4971.3	500.00	0.83	4.45	51.49	-0.43	-0.71	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0438	218.05	0.673	-0.249	4971.3	500.00	0.74	4.45	51.43	-0.42	-0.62	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0439	218.55	0.675	-0.249	4971.3	500.00	0.69	4.45	49.87	-0.43	-0.54	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0440	219.04	0.677	-0.249	4971.3	500.00	0.68	4.45	47.44	-0.47	-0.49	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0441	219.54	0.679	-0.249	4971.3	500.00	0.72	4.45	44.99	-0.54	-0.47	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0442	220.04	0.681	-0.249	4971.3	500.00	0.79	4.45	43.31	-0.64	-0.47	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0443	220.53	0.683	-0.249	4971.3	500.00	0.90	4.45	42.73	-0.76	-0.49	-55.	-57.	2330.	-2328.	-0.	0.	1.
0.0444	221.03	0.685	-0.249	4971.3	500.00	1.04	4.45	43.14	-0.89	-0.53	-55.	-57.	2330.	-2327.	-0.	0.	1.
0.0445	221.53	0.687	-0.249	4971.3	500.00	1.19	4.45	44.28	-1.04	-0.57	-55.	-57.	2330.	-2329.	-0.	0.	1.
0.0446	222.03	0.689	-0.249	4971.3	500.00	1.35	4.45	45.97	-1.20	-0.63	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0447	222.52	0.691	-0.249	4971.3	500.00	1.52	4.45	47.70	-1.35	-0.68	-55.	-57.	2331.	-2329.	-0.	0.	1.
0.0448	223.02	0.693	-0.249	4971.3	500.00	1.67	4.45	49.60	-1.51	-0.72	-55.	-57.	2331.	-2329.	-0.	0.	1.
0.0449	223.52	0.695	-0.249	4971.2	500.00	1.81	4.45	51.47	-1.65	-0.75	-55.	-57.	2331.	-2328.	-0.	0.	1.

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T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.0450	224.01	0.696	-0.248	4971.2	500.00	1.92	4.45	33.23	-1.74	-0.75	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0451	224.51	0.699	-0.248	4971.2	500.00	2.00	4.45	54.79	-1.96	-0.76	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0452	225.01	0.700	-0.248	4971.2	500.00	2.03	4.45	56.10	-1.92	-0.72	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0453	225.50	0.701	-0.248	4971.2	500.00	2.06	4.45	57.06	-1.95	-0.66	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0454	226.00	0.703	-0.248	4971.1	500.00	2.04	4.45	57.59	-1.96	-0.57	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0455	226.50	0.704	-0.247	4971.1	500.00	1.98	4.45	57.59	-1.93	-0.46	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0456	227.00	0.705	-0.247	4971.1	500.00	1.90	4.45	56.20	-1.87	-0.33	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0457	227.49	0.707	-0.247	4971.1	500.00	1.79	4.45	55.40	-1.78	-0.17	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0458	227.99	0.709	-0.247	4971.1	500.00	1.69	4.45	52.31	-1.68	-0.01	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0459	228.49	0.710	-0.246	4971.0	500.00	1.57	4.45	49.36	-1.56	0.17	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0460	228.98	0.711	-0.246	4971.0	500.00	1.47	4.45	44.71	-1.43	0.35	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0461	229.48	0.712	-0.246	4971.0	500.00	1.40	4.45	39.24	-1.29	0.52	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0462	229.98	0.714	-0.246	4971.0	500.00	1.35	4.45	33.45	-1.16	0.69	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0463	230.48	0.715	-0.245	4971.0	500.00	1.34	4.45	28.04	-1.04	0.84	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0464	230.97	0.716	-0.245	4971.0	500.00	1.35	4.45	23.60	-0.93	0.97	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0465	231.47	0.717	-0.245	4971.0	500.00	1.37	4.45	20.57	-0.84	1.08	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0466	231.97	0.718	-0.245	4971.0	500.00	1.40	4.45	19.07	-0.77	1.17	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0467	232.46	0.719	-0.245	4971.0	500.00	1.43	4.45	19.09	-0.73	1.23	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0468	232.96	0.720	-0.245	4970.9	500.00	1.45	4.45	20.49	-0.70	1.26	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0469	233.46	0.721	-0.245	4970.9	500.00	1.45	4.45	23.14	-0.70	1.27	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0470	233.96	0.723	-0.245	4970.9	500.00	1.45	4.45	26.89	-0.72	1.26	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0471	234.45	0.724	-0.245	4970.9	500.00	1.44	4.45	31.52	-0.75	1.23	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0472	234.95	0.725	-0.245	4970.9	500.00	1.43	4.45	36.85	-0.80	1.19	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0473	235.45	0.726	-0.245	4970.9	500.00	1.42	4.45	42.61	-0.85	1.14	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0474	235.94	0.727	-0.245	4970.9	500.00	1.41	4.45	48.51	-0.90	1.08	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0475	236.44	0.728	-0.245	4970.9	500.00	1.40	4.45	54.21	-0.95	1.03	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0476	236.94	0.729	-0.245	4970.9	500.00	1.39	4.45	59.42	-0.99	0.98	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0477	237.44	0.729	-0.246	4970.9	500.00	1.38	4.45	63.97	-1.01	0.95	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0478	237.93	0.730	-0.246	4970.9	500.00	1.37	4.45	67.31	-1.01	0.93	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0479	238.43	0.731	-0.245	4970.8	500.00	1.35	4.45	69.57	-0.99	0.93	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0480	238.93	0.732	-0.246	4970.8	500.00	1.33	4.45	70.43	-0.94	0.95	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0481	239.42	0.733	-0.247	4970.8	500.00	1.31	4.45	69.35	-0.86	0.98	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0482	239.92	0.734	-0.247	4970.8	500.00	1.29	4.45	67.94	-0.77	1.04	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0483	240.42	0.734	-0.247	4970.8	500.00	1.28	4.45	64.53	-0.64	1.11	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0484	240.91	0.735	-0.248	4970.8	500.00	1.29	4.45	60.19	-0.50	1.19	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0485	241.41	0.736	-0.248	4970.8	500.00	1.33	4.45	55.27	-0.35	1.28	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0486	241.91	0.736	-0.248	4970.8	500.00	1.39	4.45	50.41	-0.19	1.37	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0487	242.41	0.737	-0.249	4970.8	500.00	1.47	4.45	46.09	-0.01	1.47	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0488	242.90	0.738	-0.249	4970.7	500.00	1.57	4.45	42.62	0.17	1.56	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0489	243.40	0.739	-0.250	4970.7	500.00	1.67	4.45	40.05	0.33	1.63	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0490	243.90	0.739	-0.250	4970.7	500.00	1.76	4.45	38.37	0.49	1.70	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0491	244.39	0.740	-0.251	4970.7	500.00	1.85	4.45	37.43	0.63	1.74	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0492	244.89	0.741	-0.252	4970.7	500.00	1.91	4.45	37.11	0.75	1.76	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0493	245.39	0.741	-0.252	4970.7	500.00	1.95	4.45	37.27	0.85	1.76	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0494	245.89	0.742	-0.253	4970.6	500.00	1.96	4.45	37.34	0.92	1.73	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0495	246.38	0.743	-0.254	4970.6	500.00	1.94	4.45	38.56	0.97	1.68	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0496	246.88	0.744	-0.255	4970.6	500.00	1.90	4.45	39.72	1.00	1.61	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0497	247.38	0.745	-0.256	4970.6	500.00	1.82	4.45	40.95	1.01	1.52	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0498	247.87	0.746	-0.257	4970.5	500.00	1.73	4.45	42.33	1.00	1.41	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0499	248.37	0.747	-0.258	4970.6	500.00	1.62	4.45	43.14	0.98	1.29	-55.	-57.	2331.	-2328.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA (bar) DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.0500	248.87	0.748	-0.259	4970.5	500.00	1.50	4.45	44.08	0.94	1.15	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0501	249.36	0.749	-0.260	4970.5	500.00	1.37	4.45	44.74	0.90	1.03	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0502	249.86	0.750	-0.261	4970.5	500.00	1.25	4.45	45.02	0.87	0.90	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0503	250.36	0.751	-0.262	4970.5	500.00	1.14	4.45	44.80	0.83	0.78	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0504	250.86	0.752	-0.263	4970.5	500.00	1.05	4.45	44.04	0.81	0.67	-55.	-57.	2331.	-2324.	-0.	0.	1.
0.0505	251.35	0.753	-0.264	4970.5	500.00	0.98	4.45	42.81	0.80	0.57	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0506	251.85	0.754	-0.265	4970.5	500.00	0.94	4.45	41.31	0.81	0.49	-55.	-57.	2331.	-2324.	-0.	0.	1.
0.0507	252.35	0.755	-0.266	4970.5	500.00	0.93	4.45	39.91	0.83	0.42	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0508	252.84	0.756	-0.267	4970.5	500.00	0.95	4.45	38.77	0.87	0.37	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0509	253.34	0.757	-0.269	4970.5	500.00	0.99	4.45	38.73	0.93	0.34	-55.	-57.	2331.	-2329.	-0.	0.	1.
0.0510	253.84	0.759	-0.270	4970.5	500.00	1.06	4.45	39.28	1.01	0.32	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0511	254.33	0.760	-0.271	4970.5	500.00	1.14	4.45	40.51	1.09	0.31	-55.	-57.	2331.	-2326.	-0.	0.	1.
0.0512	254.83	0.761	-0.272	4970.5	500.00	1.23	4.45	42.25	1.19	0.31	-55.	-57.	2331.	-2324.	-0.	0.	1.
0.0513	255.33	0.762	-0.273	4970.5	500.00	1.33	4.45	44.31	1.29	0.32	-55.	-57.	2331.	-2326.	-0.	0.	1.
0.0514	255.83	0.763	-0.275	4970.4	500.00	1.44	4.45	46.52	1.40	0.33	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0515	256.32	0.764	-0.276	4970.4	500.00	1.54	4.45	48.75	1.50	0.34	-55.	-57.	2331.	-2323.	-0.	0.	1.
0.0516	256.82	0.766	-0.277	4970.4	500.00	1.63	4.45	50.87	1.59	0.34	-55.	-57.	2331.	-2324.	-0.	0.	1.
0.0517	257.32	0.767	-0.278	4970.4	500.00	1.70	4.45	52.82	1.67	0.33	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0518	257.81	0.769	-0.279	4970.4	500.00	1.76	4.45	54.50	1.73	0.30	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0519	258.31	0.770	-0.280	4970.4	500.00	1.79	4.45	55.87	1.77	0.26	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0520	258.81	0.772	-0.282	4970.4	500.00	1.81	4.45	56.84	1.80	0.20	-55.	-57.	2331.	-2324.	-0.	0.	1.
0.0521	259.30	0.773	-0.283	4970.3	500.00	1.80	4.45	57.35	1.79	0.13	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0522	259.80	0.775	-0.284	4970.3	500.00	1.77	4.45	57.31	1.77	0.04	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0523	260.30	0.776	-0.285	4970.3	500.00	1.72	4.45	56.64	1.72	-0.07	-55.	-57.	2331.	-2329.	-0.	0.	1.
0.0524	260.79	0.778	-0.287	4970.3	500.00	1.66	4.45	55.27	1.65	-0.19	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0525	261.29	0.780	-0.288	4970.3	500.00	1.60	4.45	53.15	1.57	-0.32	-55.	-57.	2331.	-2326.	-0.	0.	1.
0.0526	261.79	0.782	-0.289	4970.3	500.00	1.54	4.45	50.29	1.47	-0.46	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0527	262.28	0.784	-0.290	4970.2	500.00	1.49	4.45	46.78	1.34	-0.53	-55.	-57.	2331.	-2323.	-0.	0.	1.
0.0528	262.78	0.785	-0.292	4970.2	500.00	1.45	4.45	42.34	1.25	-0.73	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0529	263.28	0.787	-0.293	4970.2	500.00	1.43	4.45	38.80	1.13	-0.87	-55.	-57.	2331.	-2324.	-0.	0.	1.
0.0530	263.78	0.789	-0.294	4970.2	500.00	1.42	4.45	35.04	1.02	-0.99	-55.	-57.	2331.	-2324.	-0.	0.	1.
0.0531	264.27	0.791	-0.295	4970.2	500.00	1.43	4.45	31.79	0.92	-1.10	-55.	-57.	2331.	-2323.	-0.	0.	1.
0.0532	264.77	0.793	-0.296	4970.2	500.00	1.45	4.45	29.57	0.83	-1.19	-55.	-57.	2331.	-2329.	-0.	0.	1.
0.0533	265.27	0.795	-0.297	4970.2	500.00	1.47	4.45	28.22	0.75	-1.27	-55.	-57.	2331.	-2324.	-0.	0.	1.
0.0534	265.76	0.797	-0.298	4970.2	500.00	1.49	4.45	27.85	0.68	-1.32	-55.	-57.	2331.	-2323.	-0.	0.	1.
0.0535	266.26	0.799	-0.299	4970.2	500.00	1.50	4.45	28.41	0.64	-1.36	-55.	-57.	2331.	-2327.	-0.	0.	1.
0.0536	266.76	0.801	-0.300	4970.1	500.00	1.51	4.45	29.81	0.60	-1.38	-55.	-57.	2331.	-2323.	-0.	0.	1.
0.0537	267.25	0.803	-0.301	4970.1	500.00	1.50	4.45	31.97	0.59	-1.37	-55.	-57.	2331.	-2326.	-0.	0.	1.
0.0538	267.75	0.805	-0.302	4970.1	500.00	1.49	4.45	34.76	0.58	-1.36	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0539	268.25	0.807	-0.303	4970.1	500.00	1.47	4.45	38.06	0.59	-1.35	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0540	268.74	0.809	-0.304	4970.1	500.00	1.45	4.45	41.71	0.59	-1.32	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0541	269.24	0.812	-0.305	4970.1	500.00	1.42	4.45	45.55	0.60	-1.29	-55.	-57.	2331.	-2324.	-0.	0.	1.
0.0542	269.74	0.814	-0.306	4970.1	500.00	1.39	4.45	49.38	0.61	-1.25	-55.	-57.	2331.	-2323.	-0.	0.	1.
0.0543	270.23	0.816	-0.306	4970.1	500.00	1.36	4.45	53.00	0.61	-1.21	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0544	270.73	0.818	-0.307	4970.1	500.00	1.33	4.45	56.19	0.60	-1.18	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0545	271.23	0.820	-0.308	4970.0	500.00	1.30	4.45	58.75	0.59	-1.16	-55.	-57.	2331.	-2323.	-0.	0.	1.
0.0546	271.72	0.822	-0.309	4970.0	500.00	1.28	4.45	60.51	0.55	-1.15	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0547	272.22	0.824	-0.309	4970.0	500.00	1.26	4.45	61.33	0.50	-1.15	-55.	-57.	2331.	-2326.	-0.	0.	1.
0.0548	272.72	0.827	-0.310	4970.0	500.00	1.24	4.45	61.14	0.43	-1.16	-55.	-57.	2331.	-2324.	-0.	0.	1.
0.0549	273.22	0.829	-0.310	4970.0	500.00	1.24	4.45	59.99	0.35	-1.19	-55.	-57.	2331.	-2327.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA~ DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.0550	273.71	0.831	-0.311	4970.0	500.00	1.24	4.45	57.97	0.25	-1.22	-55.	-57.	2331.	-2323.	-0.	0.	1.
0.0551	274.21	0.833	-0.311	4970.0	500.00	1.26	4.45	55.36	0.16	-1.26	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0552	274.71	0.836	-0.312	4970.0	500.00	1.30	4.45	52.48	0.01	-1.30	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0553	275.20	0.838	-0.312	4970.0	500.00	1.36	4.45	49.64	-0.13	-1.35	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0554	275.70	0.840	-0.313	4970.0	500.00	1.43	4.45	47.10	-0.27	-1.40	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0555	276.20	0.842	-0.313	4970.0	500.00	1.50	4.45	45.02	-0.41	-1.45	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0556	276.69	0.845	-0.313	4969.9	500.00	1.58	4.45	43.47	-0.54	-1.48	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0557	277.19	0.847	-0.314	4969.9	500.00	1.65	4.45	42.43	-0.67	-1.51	-55.	-57.	2331.	-2326.	-0.	0.	1.
0.0558	277.69	0.849	-0.314	4969.9	500.00	1.72	4.45	41.86	-0.79	-1.53	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0559	278.18	0.851	-0.314	4969.9	500.00	1.77	4.45	41.67	-0.90	-1.53	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0560	278.68	0.854	-0.314	4969.9	500.00	1.81	4.45	41.79	-0.99	-1.51	-55.	-57.	2331.	-2326.	-0.	0.	1.
0.0561	279.18	0.856	-0.315	4969.9	500.00	1.82	4.45	42.14	-1.06	-1.48	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0562	279.67	0.858	-0.315	4969.8	500.00	1.81	4.45	42.64	-1.12	-1.43	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0563	280.17	0.860	-0.315	4969.8	500.00	1.79	4.45	43.21	-1.15	-1.36	-55.	-57.	2331.	-2323.	-0.	0.	1.
0.0564	280.67	0.862	-0.315	4969.8	500.00	1.74	4.45	43.75	-1.18	-1.28	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0565	281.16	0.864	-0.315	4969.8	500.00	1.68	4.45	44.28	-1.19	-1.19	-55.	-57.	2331.	-2326.	-0.	0.	1.
0.0566	281.66	0.865	-0.315	4969.8	500.00	1.60	4.45	44.64	-1.18	-1.08	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0567	282.16	0.868	-0.315	4969.8	500.00	1.52	4.45	44.77	-1.17	-0.97	-55.	-57.	2331.	-2326.	-0.	0.	1.
0.0568	282.65	0.870	-0.315	4969.8	500.00	1.44	4.45	44.63	-1.15	-0.86	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0569	283.15	0.872	-0.314	4969.7	500.00	1.35	4.45	44.16	-1.13	-0.74	-55.	-57.	2331.	-2326.	-0.	0.	1.
0.0570	283.65	0.873	-0.314	4969.7	500.00	1.28	4.45	43.35	-1.11	-0.63	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0571	284.15	0.875	-0.314	4969.7	500.00	1.21	4.45	42.25	-1.09	-0.52	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0572	284.64	0.877	-0.314	4969.7	500.00	1.16	4.45	40.98	-1.08	-0.43	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0573	285.14	0.879	-0.314	4969.7	500.00	1.13	4.45	39.73	-1.08	-0.34	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0574	285.64	0.881	-0.314	4969.7	500.00	1.12	4.45	38.70	-1.07	-0.25	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0575	286.13	0.882	-0.314	4969.7	500.00	1.12	4.45	38.11	-1.11	-0.20	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0576	286.63	0.884	-0.313	4969.7	500.00	1.15	4.45	38.07	-1.14	-0.14	-55.	-57.	2331.	-2323.	-0.	0.	1.
0.0577	287.13	0.886	-0.313	4969.7	500.00	1.19	4.45	38.53	-1.19	-0.10	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0578	287.62	0.887	-0.313	4969.7	500.00	1.23	4.45	39.75	-1.23	-0.07	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0579	288.12	0.889	-0.313	4969.7	500.00	1.29	4.45	41.32	-1.27	-0.04	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0580	288.62	0.891	-0.313	4969.7	500.00	1.35	4.45	43.21	-1.33	-0.02	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0581	289.11	0.892	-0.312	4969.7	500.00	1.41	4.45	45.23	-1.41	-0.00	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0582	289.61	0.894	-0.312	4969.6	500.00	1.47	4.45	47.40	-1.47	0.02	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0583	290.11	0.895	-0.312	4969.6	500.00	1.52	4.45	49.46	-1.52	0.04	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0584	290.60	0.897	-0.312	4969.6	500.00	1.57	4.45	51.37	-1.57	0.07	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0585	291.10	0.898	-0.312	4969.6	500.00	1.60	4.45	53.03	-1.60	0.10	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0586	291.60	0.899	-0.312	4969.6	500.00	1.62	4.45	54.37	-1.62	0.15	-55.	-57.	2331.	-2322.	-0.	0.	1.
0.0587	292.09	0.901	-0.311	4969.6	500.00	1.63	4.45	55.34	-1.62	0.20	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0588	292.59	0.902	-0.311	4969.6	500.00	1.63	4.45	55.86	-1.61	0.27	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0589	293.09	0.903	-0.311	4969.6	500.00	1.62	4.45	55.87	-1.59	0.34	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0590	293.58	0.904	-0.311	4969.5	500.00	1.59	4.45	55.35	-1.53	0.43	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0591	294.08	0.905	-0.311	4969.5	500.00	1.56	4.45	54.24	-1.47	0.52	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0592	294.58	0.907	-0.311	4969.5	500.00	1.53	4.45	52.57	-1.40	0.63	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0593	295.08	0.908	-0.311	4969.5	500.00	1.50	4.45	50.39	-1.31	0.73	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0594	295.57	0.909	-0.310	4969.5	500.00	1.48	4.45	47.80	-1.21	0.84	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0595	296.07	0.910	-0.310	4969.5	500.00	1.46	4.45	44.97	-1.11	0.95	-55.	-57.	2331.	-2322.	-0.	0.	1.
0.0596	296.57	0.911	-0.310	4969.5	500.00	1.45	4.45	42.12	-1.01	1.05	-55.	-57.	2331.	-2325.	-0.	0.	1.
0.0597	297.06	0.912	-0.310	4969.4	500.00	1.46	4.45	39.47	-0.91	1.14	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0598	297.56	0.912	-0.310	4969.4	500.00	1.47	4.45	37.22	-0.81	1.23	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0599	298.06	0.913	-0.310	4969.4	500.00	1.49	4.45	35.50	-0.71	1.31	-55.	-57.	2331.	-2328.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA (---) DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.0600	298.55	0.914	-0.310	4969.4	500.00	1.51	4.45	34.39	-0.53	1.37	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0601	299.05	0.915	-0.310	4969.4	500.00	1.52	4.45	33.92	-0.54	1.42	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0602	299.55	0.916	-0.311	4969.4	500.00	1.53	4.45	34.39	-0.42	1.45	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0603	300.04	0.917	-0.311	4969.4	500.00	1.53	4.45	34.80	-0.44	1.47	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0604	300.54	0.918	-0.311	4969.4	500.00	1.53	4.45	36.33	-0.37	1.49	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0605	301.04	0.919	-0.311	4969.4	500.00	1.52	4.45	37.69	-0.36	1.47	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0606	301.53	0.919	-0.311	4969.3	500.00	1.50	4.45	39.59	-0.33	1.46	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0607	302.03	0.920	-0.312	4969.3	500.00	1.47	4.45	41.93	-0.31	1.44	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0608	302.53	0.921	-0.312	4969.3	500.00	1.44	4.45	44.30	-0.29	1.41	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0609	303.02	0.922	-0.313	4969.3	500.00	1.41	4.45	46.59	-0.27	1.38	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0610	303.52	0.923	-0.313	4969.3	500.00	1.37	4.45	48.97	-0.25	1.35	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0611	304.02	0.923	-0.313	4969.3	500.00	1.34	4.45	50.94	-0.23	1.32	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0612	304.52	0.924	-0.314	4969.3	500.00	1.31	4.45	52.53	-0.19	1.29	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0613	305.01	0.925	-0.315	4969.3	500.00	1.28	4.45	53.79	-0.15	1.27	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0614	305.51	0.926	-0.315	4969.3	500.00	1.26	4.45	54.37	-0.10	1.25	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0615	306.01	0.927	-0.316	4969.3	500.00	1.24	4.45	54.35	-0.07	1.24	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0616	306.50	0.927	-0.316	4969.2	500.00	1.24	4.45	53.77	0.03	1.24	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0617	307.00	0.928	-0.317	4969.2	500.00	1.25	4.45	52.72	0.12	1.24	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0618	307.50	0.929	-0.318	4969.2	500.00	1.27	4.45	51.35	0.22	1.25	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0619	307.99	0.930	-0.318	4969.2	500.00	1.30	4.45	49.83	0.32	1.26	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0620	308.49	0.930	-0.319	4969.2	500.00	1.35	4.45	48.34	0.43	1.29	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0621	308.99	0.931	-0.320	4969.2	500.00	1.40	4.45	47.02	0.54	1.29	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0622	309.48	0.932	-0.321	4969.2	500.00	1.46	4.45	45.94	0.66	1.30	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0623	309.98	0.933	-0.321	4969.2	500.00	1.52	4.45	45.16	0.77	1.31	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0624	310.48	0.934	-0.322	4969.2	500.00	1.57	4.45	44.67	0.86	1.31	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0625	310.97	0.934	-0.323	4969.2	500.00	1.62	4.45	44.44	0.97	1.30	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0626	311.47	0.935	-0.324	4969.1	500.00	1.67	4.45	44.43	1.05	1.28	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0627	311.97	0.936	-0.325	4969.1	500.00	1.69	4.45	44.58	1.14	1.25	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0628	312.46	0.937	-0.326	4969.1	500.00	1.71	4.45	44.85	1.21	1.21	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0629	312.96	0.938	-0.327	4969.1	500.00	1.71	4.45	45.16	1.26	1.15	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0630	313.46	0.939	-0.328	4969.1	500.00	1.69	4.45	45.47	1.30	1.10	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0631	313.95	0.940	-0.329	4969.1	500.00	1.67	4.45	45.72	1.33	1.01	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0632	314.45	0.941	-0.331	4969.0	500.00	1.63	4.45	45.85	1.35	0.92	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0633	314.95	0.942	-0.332	4969.0	500.00	1.58	4.45	45.31	1.39	0.83	-55.	-57.	2331.	-2328.	-0.	0.	1.
0.0634	315.45	0.944	-0.333	4969.0	500.00	1.52	4.45	45.57	1.34	0.73	-55.	-57.	2331.	-2329.	-0.	0.	1.
0.0635	315.94	0.945	-0.334	4969.0	500.00	1.47	4.45	45.08	1.33	0.62	-55.	-57.	2331.	-2329.	-0.	0.	1.
0.0636	316.44	0.946	-0.335	4969.0	500.00	1.41	4.45	44.34	1.31	0.52	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0637	316.94	0.947	-0.337	4969.0	500.00	1.36	4.45	43.43	1.29	0.41	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0638	317.43	0.949	-0.338	4969.0	500.00	1.31	4.45	42.35	1.28	0.31	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0639	317.93	0.950	-0.339	4969.0	500.00	1.28	4.45	41.22	1.23	0.22	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0640	318.43	0.951	-0.340	4969.0	500.00	1.26	4.45	40.18	1.23	0.13	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0641	318.92	0.953	-0.342	4968.9	500.00	1.25	4.45	39.35	1.25	0.05	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0642	319.42	0.954	-0.343	4968.9	500.00	1.25	4.45	38.88	1.25	-0.02	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0643	319.92	0.955	-0.344	4968.9	500.00	1.26	4.45	38.82	1.26	-0.09	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0644	320.41	0.957	-0.345	4968.9	500.00	1.28	4.45	39.21	1.27	-0.15	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0645	320.91	0.958	-0.347	4968.9	500.00	1.31	4.45	40.04	1.29	-0.19	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0646	321.41	0.960	-0.348	4968.9	500.00	1.34	4.45	41.24	1.32	-0.24	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0647	321.90	0.962	-0.349	4968.9	500.00	1.37	4.45	42.73	1.34	-0.28	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0648	322.40	0.963	-0.350	4968.9	500.00	1.40	4.45	44.42	1.37	-0.31	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0649	322.90	0.965	-0.351	4968.9	500.00	1.42	4.45	46.19	1.39	-0.34	-55.	-57.	2332.	-2329.	-0.	0.	1.

FLECHETTE GROUND POINT

T	X	Y	Z	V	P	ALPHA	MACH	PHI	ALPHA	BETA	L-N	L-P	H-N	H-P	S	TAU	K-T
SEC	FT	FT	FT	FT/SEC	RAD/SEC	DEG		DEG	DEG	DEG	1/SEC	1/SEC	RAD/SEC	RAD/SEC			DEG
0.0650	323.39	0.966	-0.353	4968.9	500.00	1.47	4.45	47.95	1.42	-0.38	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0651	323.89	0.968	-0.354	4968.9	500.00	1.49	4.45	49.62	1.43	-0.42	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0652	324.39	0.970	-0.355	4968.8	500.00	1.51	4.45	51.10	1.44	-0.46	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0653	324.89	0.972	-0.356	4968.8	500.00	1.52	4.45	52.32	1.44	-0.50	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0654	325.38	0.973	-0.357	4968.8	500.00	1.53	4.45	53.21	1.42	-0.55	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0655	325.88	0.975	-0.358	4968.8	500.00	1.53	4.45	53.73	1.40	-0.61	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0656	326.38	0.977	-0.360	4968.8	500.00	1.52	4.45	53.83	1.36	-0.67	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0657	326.87	0.979	-0.361	4968.8	500.00	1.51	4.45	53.49	1.31	-0.74	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0658	327.37	0.981	-0.362	4968.8	500.00	1.49	4.45	52.69	1.25	-0.82	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0659	327.87	0.983	-0.363	4968.8	500.00	1.48	4.45	51.48	1.18	-0.89	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0660	328.36	0.985	-0.364	4968.7	500.00	1.47	4.45	49.91	1.09	-0.97	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0661	328.86	0.987	-0.365	4968.7	500.00	1.46	4.45	48.07	1.01	-1.05	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0662	329.36	0.989	-0.366	4968.7	500.00	1.46	4.45	46.09	0.91	-1.14	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0663	329.85	0.991	-0.367	4968.7	500.00	1.46	4.45	44.11	0.82	-1.21	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0664	330.35	0.993	-0.368	4968.7	500.00	1.47	4.45	42.27	0.72	-1.28	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0665	330.85	0.996	-0.369	4968.7	500.00	1.48	4.45	40.63	0.62	-1.33	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0666	331.34	0.998	-0.370	4968.7	500.00	1.50	4.45	39.44	0.53	-1.39	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0667	331.84	1.000	-0.371	4968.7	500.00	1.52	4.45	38.59	0.45	-1.45	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0668	332.34	1.002	-0.371	4968.7	500.00	1.53	4.45	38.15	0.35	-1.49	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0669	332.83	1.004	-0.372	4968.6	500.00	1.54	4.45	38.12	0.27	-1.51	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0670	333.33	1.006	-0.373	4968.6	500.00	1.54	4.45	38.47	0.22	-1.52	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0671	333.83	1.009	-0.374	4968.6	500.00	1.54	4.45	39.15	0.16	-1.53	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0672	334.32	1.011	-0.374	4968.6	500.00	1.53	4.45	40.12	0.11	-1.52	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0673	334.82	1.013	-0.375	4968.6	500.00	1.51	4.45	41.30	0.06	-1.51	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0674	335.32	1.015	-0.375	4968.6	500.00	1.48	4.45	42.63	0.02	-1.49	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0675	335.82	1.017	-0.376	4968.6	500.00	1.46	4.45	44.04	-0.01	-1.45	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0676	336.31	1.020	-0.376	4968.6	500.00	1.43	4.45	45.45	-0.05	-1.42	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0677	336.81	1.022	-0.377	4968.5	500.00	1.39	4.45	46.78	-0.09	-1.39	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0678	337.31	1.024	-0.377	4968.5	500.00	1.36	4.45	47.95	-0.12	-1.36	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0679	337.80	1.026	-0.378	4968.5	500.00	1.33	4.45	48.89	-0.17	-1.32	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0680	338.30	1.029	-0.378	4968.5	500.00	1.31	4.45	49.55	-0.21	-1.29	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0681	338.80	1.031	-0.378	4968.5	500.00	1.29	4.45	49.87	-0.27	-1.26	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0682	339.29	1.033	-0.379	4968.5	500.00	1.28	4.45	49.90	-0.32	-1.24	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0683	339.79	1.035	-0.379	4968.5	500.00	1.27	4.45	49.62	-0.39	-1.21	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0684	340.29	1.037	-0.379	4968.5	500.00	1.28	4.45	49.12	-0.45	-1.19	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0685	340.78	1.039	-0.379	4968.5	500.00	1.30	4.45	48.46	-0.54	-1.18	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0686	341.28	1.041	-0.380	4968.5	500.00	1.32	4.45	47.75	-0.63	-1.15	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0687	341.78	1.044	-0.380	4968.4	500.00	1.35	4.45	47.07	-0.72	-1.15	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0688	342.27	1.046	-0.380	4968.4	500.00	1.39	4.45	46.50	-0.81	-1.14	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0689	342.77	1.048	-0.380	4968.4	500.00	1.43	4.45	46.07	-0.90	-1.12	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0690	343.27	1.050	-0.380	4968.4	500.00	1.47	4.45	45.82	-0.98	-1.10	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0691	343.76	1.052	-0.380	4968.4	500.00	1.52	4.45	45.70	-1.07	-1.08	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0692	344.26	1.054	-0.380	4968.4	500.00	1.55	4.45	45.73	-1.15	-1.05	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0693	344.76	1.056	-0.380	4968.4	500.00	1.59	4.45	45.88	-1.22	-1.01	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0694	345.25	1.058	-0.380	4968.4	500.00	1.61	4.45	46.09	-1.28	-0.97	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0695	345.75	1.060	-0.380	4968.4	500.00	1.62	4.45	46.34	-1.34	-0.92	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0696	346.25	1.062	-0.380	4968.3	500.00	1.62	4.45	46.57	-1.39	-0.86	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0697	346.75	1.064	-0.380	4968.3	500.00	1.62	4.45	46.75	-1.41	-0.79	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0698	347.24	1.065	-0.380	4968.3	500.00	1.60	4.45	46.83	-1.43	-0.71	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0699	347.74	1.067	-0.379	4968.3	500.00	1.58	4.45	46.78	-1.45	-0.63	-55.	-57.	2332.	-2329.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA~ DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.0700	348.24	1.069	-0.373	4969.3	500.00	1.55	4.45	46.57	-1.45	-0.54	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0701	348.73	1.071	-0.373	4969.3	500.00	1.51	4.45	46.18	-1.44	-0.44	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0702	349.23	1.072	-0.373	4969.3	500.00	1.47	4.45	45.50	-1.43	-0.35	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0703	349.73	1.074	-0.373	4968.2	500.00	1.44	4.45	44.86	-1.42	-0.25	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0704	350.22	1.075	-0.373	4968.2	500.00	1.41	4.45	43.98	-1.40	-0.15	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0705	350.72	1.077	-0.379	4969.2	500.00	1.35	4.45	43.12	-1.38	-0.05	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0706	351.21	1.078	-0.378	4969.2	500.00	1.36	4.45	42.07	-1.36	0.03	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0707	351.71	1.080	-0.379	4969.2	500.00	1.34	4.45	41.22	-1.34	0.12	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0708	352.21	1.081	-0.378	4969.2	500.00	1.33	4.45	40.54	-1.32	0.20	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0709	352.70	1.083	-0.377	4969.2	500.00	1.33	4.45	40.13	-1.30	0.27	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0710	353.20	1.084	-0.377	4969.2	500.00	1.34	4.45	40.07	-1.29	0.34	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0711	353.70	1.086	-0.377	4969.2	500.00	1.35	4.45	40.25	-1.27	0.41	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0712	354.19	1.087	-0.377	4969.2	500.00	1.36	4.45	40.80	-1.25	0.46	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0713	354.69	1.088	-0.377	4968.1	500.00	1.38	4.45	41.45	-1.25	0.51	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0714	355.19	1.089	-0.375	4968.1	500.00	1.40	4.45	42.74	-1.24	0.56	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0715	355.69	1.091	-0.376	4968.1	500.00	1.41	4.45	44.00	-1.28	0.60	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0716	356.18	1.092	-0.375	4968.1	500.00	1.43	4.45	45.36	-1.29	0.64	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0717	356.68	1.093	-0.375	4968.1	500.00	1.44	4.45	46.74	-1.27	0.68	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0718	357.17	1.094	-0.376	4968.1	500.00	1.45	4.45	49.07	-1.26	0.72	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0719	357.67	1.095	-0.375	4968.1	500.00	1.46	4.45	49.29	-1.25	0.76	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0720	358.17	1.096	-0.376	4968.1	500.00	1.47	4.45	50.29	-1.23	0.80	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0721	358.65	1.097	-0.376	4968.1	500.00	1.47	4.45	51.36	-1.20	0.85	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0722	359.15	1.098	-0.376	4968.0	500.00	1.46	4.45	51.53	-1.15	0.90	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0723	359.66	1.099	-0.376	4968.0	500.00	1.46	4.45	51.69	-1.11	0.95	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0724	360.15	1.100	-0.376	4968.0	500.00	1.45	4.45	51.50	-1.05	1.00	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0725	360.65	1.101	-0.376	4968.0	500.00	1.45	4.45	50.99	-0.99	1.05	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0726	361.15	1.102	-0.376	4968.0	500.00	1.44	4.45	50.18	-0.92	1.11	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0727	361.64	1.103	-0.375	4968.0	500.00	1.44	4.45	47.12	-0.84	1.17	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0728	362.14	1.104	-0.376	4968.0	500.00	1.44	4.45	47.67	-0.75	1.23	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0729	362.64	1.105	-0.376	4968.0	500.00	1.45	4.45	45.54	-0.66	1.29	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0730	363.13	1.106	-0.376	4967.9	500.00	1.46	4.45	45.21	-0.57	1.34	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0731	363.63	1.106	-0.377	4967.9	500.00	1.47	4.45	43.96	-0.46	1.39	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0732	364.13	1.107	-0.377	4967.9	500.00	1.48	4.45	42.86	-0.35	1.43	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0733	364.62	1.108	-0.377	4967.9	500.00	1.50	4.45	42.02	-0.23	1.47	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0734	365.12	1.109	-0.378	4967.9	500.00	1.51	4.45	41.40	-0.20	1.50	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0735	365.62	1.109	-0.378	4967.9	500.00	1.52	4.45	41.35	-0.12	1.52	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0736	366.11	1.110	-0.379	4967.9	500.00	1.53	4.45	40.96	-0.03	1.53	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0737	366.61	1.111	-0.379	4967.9	500.00	1.53	4.45	41.12	0.03	1.53	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0738	367.11	1.112	-0.379	4967.9	500.00	1.53	4.45	41.48	0.10	1.53	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0739	367.60	1.112	-0.380	4967.8	500.00	1.52	4.45	42.02	0.15	1.51	-55.	-57.	2332.	-2329.	-1.	0.	1.
0.0740	368.10	1.113	-0.381	4967.8	500.00	1.51	4.45	42.69	0.21	1.49	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0741	368.60	1.114	-0.381	4967.8	500.00	1.49	4.45	43.45	0.27	1.47	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0742	369.09	1.115	-0.382	4967.8	500.00	1.47	4.45	44.24	0.31	1.43	-55.	-57.	2332.	-2329.	-1.	0.	1.
0.0743	369.59	1.116	-0.382	4967.8	500.00	1.44	4.45	45.02	0.36	1.40	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0744	370.08	1.116	-0.383	4967.8	500.00	1.41	4.45	45.74	0.40	1.35	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0745	370.58	1.117	-0.384	4967.8	500.00	1.39	4.45	46.36	0.45	1.31	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0746	371.08	1.118	-0.385	4967.8	500.00	1.36	4.45	46.94	0.49	1.27	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0747	371.57	1.119	-0.385	4967.8	500.00	1.34	4.45	47.16	0.55	1.23	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0748	372.07	1.120	-0.386	4967.7	500.00	1.33	4.45	47.30	0.59	1.19	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0749	372.57	1.121	-0.387	4967.7	500.00	1.32	4.45	47.29	0.65	1.15	-55.	-57.	2332.	-2329.	-0.	0.	1.

FLECHETTE GROUND POINT

T	X	Y	Z	V	P	ALPHA (==)	MACH	PHI	ALPHA	BETA	L-V	L-P	W-A	W-P	S	TAU	K-T
SEC	FT	FT	FT	FT/SEC	RAD/SEC	DEG		DEG	DEG	DEG	1/SEC	1/SEC	RAD/SEC	RAD/SEC			DEG
0.0750	373.06	1.121	-0.388	4967.7	500.00	1.31	4.45	47.14	0.70	1.11	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0751	373.56	1.122	-0.389	4967.7	500.00	1.32	4.45	46.90	0.76	1.07	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0752	374.06	1.123	-0.390	4967.7	500.00	1.33	4.45	46.51	0.83	1.04	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0753	374.55	1.124	-0.391	4967.7	500.00	1.34	4.45	46.32	0.90	1.00	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0754	375.05	1.125	-0.392	4967.7	500.00	1.37	4.45	46.08	0.96	0.97	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0755	375.55	1.126	-0.393	4967.7	500.00	1.39	4.45	45.92	1.03	0.93	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0756	376.04	1.127	-0.394	4967.7	500.00	1.42	4.45	45.95	1.10	0.90	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0757	376.54	1.128	-0.395	4967.7	500.00	1.45	4.45	45.99	1.17	0.86	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0758	377.04	1.129	-0.396	4967.7	500.00	1.49	4.45	46.02	1.23	0.82	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0759	377.53	1.130	-0.398	4967.6	500.00	1.51	4.45	46.21	1.29	0.77	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0760	378.03	1.131	-0.399	4967.6	500.00	1.53	4.45	46.46	1.35	0.72	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0761	378.53	1.133	-0.400	4967.6	500.00	1.55	4.45	46.72	1.39	0.67	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0762	379.02	1.134	-0.401	4967.6	500.00	1.55	4.45	46.97	1.43	0.61	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0763	379.52	1.135	-0.402	4967.6	500.00	1.56	4.45	47.17	1.46	0.54	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0764	380.02	1.136	-0.404	4967.6	500.00	1.56	4.45	47.30	1.48	0.47	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0765	380.51	1.138	-0.405	4967.6	500.00	1.55	4.45	47.31	1.50	0.40	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0766	381.01	1.139	-0.406	4967.6	500.00	1.53	4.45	47.20	1.50	0.31	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0767	381.51	1.140	-0.407	4967.5	500.00	1.52	4.45	46.95	1.50	0.23	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0768	382.00	1.142	-0.408	4967.5	500.00	1.49	4.45	46.54	1.49	0.14	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0769	382.50	1.143	-0.410	4967.5	500.00	1.47	4.45	45.99	1.47	0.05	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0770	383.00	1.145	-0.411	4967.5	500.00	1.45	4.45	45.33	1.45	-0.04	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0771	383.49	1.146	-0.412	4967.5	500.00	1.43	4.45	44.57	1.43	-0.13	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0772	383.99	1.148	-0.414	4967.5	500.00	1.41	4.45	43.78	1.40	-0.22	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0773	384.49	1.149	-0.415	4967.5	500.00	1.40	4.45	43.00	1.37	-0.30	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0774	384.98	1.151	-0.416	4967.5	500.00	1.39	4.45	42.31	1.34	-0.39	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0775	385.48	1.153	-0.417	4967.4	500.00	1.39	4.45	41.77	1.31	-0.46	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0776	385.98	1.154	-0.419	4967.4	500.00	1.39	4.45	41.41	1.28	-0.53	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0777	386.47	1.156	-0.420	4967.4	500.00	1.39	4.45	41.27	1.25	-0.60	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0778	386.97	1.158	-0.421	4967.4	500.00	1.39	4.45	41.38	1.23	-0.66	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0779	387.47	1.160	-0.422	4967.4	500.00	1.40	4.45	41.73	1.20	-0.72	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0780	387.96	1.162	-0.423	4967.4	500.00	1.41	4.45	42.29	1.18	-0.77	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0781	388.46	1.163	-0.424	4967.4	500.00	1.42	4.45	43.04	1.15	-0.82	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0782	388.96	1.165	-0.425	4967.4	500.00	1.42	4.45	43.93	1.13	-0.86	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0783	389.45	1.167	-0.427	4967.4	500.00	1.43	4.45	44.91	1.11	-0.90	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0784	389.95	1.169	-0.428	4967.4	500.00	1.44	4.45	45.93	1.08	-0.94	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0785	390.44	1.171	-0.429	4967.3	500.00	1.44	4.45	46.92	1.05	-0.98	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0786	390.94	1.173	-0.430	4967.3	500.00	1.44	4.45	47.83	1.02	-1.02	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0787	391.44	1.175	-0.431	4967.3	500.00	1.44	4.45	48.61	0.98	-1.05	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0788	391.93	1.177	-0.432	4967.3	500.00	1.44	4.45	49.21	0.94	-1.09	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0789	392.43	1.179	-0.433	4967.3	500.00	1.43	4.45	49.61	0.89	-1.12	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0790	392.93	1.181	-0.434	4967.3	500.00	1.43	4.45	49.79	0.83	-1.16	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0791	393.42	1.184	-0.434	4967.3	500.00	1.43	4.45	49.72	0.77	-1.20	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0792	393.92	1.186	-0.435	4967.3	500.00	1.42	4.45	49.42	0.71	-1.24	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0793	394.42	1.188	-0.436	4967.3	500.00	1.42	4.45	48.91	0.63	-1.28	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0794	394.91	1.190	-0.437	4967.3	500.00	1.43	4.45	48.24	0.55	-1.32	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0795	395.41	1.192	-0.438	4967.2	500.00	1.43	4.45	47.44	0.47	-1.35	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0796	395.91	1.194	-0.439	4967.2	500.00	1.44	4.45	46.59	0.38	-1.39	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0797	396.40	1.197	-0.439	4967.2	500.00	1.45	4.45	45.73	0.29	-1.42	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0798	396.90	1.199	-0.440	4967.2	500.00	1.46	4.45	44.92	0.20	-1.45	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0799	397.40	1.201	-0.440	4967.2	500.00	1.47	4.45	44.22	0.11	-1.47	-55.	-57.	2332.	-2329.	-0.	0.	1.

FLECHETTE GROUND POINT

T	X	Y	Z	V	P	ALPHA	MACH	PHI	ALPHA	BETA	L-M	L-P	W-N	W-P	S	TAU	K-T
SEC	FT	FT	FT	FT/SEC	RAD/SEC	DEG		DEG	DEG	DEG	1/SEC	1/SEC	RAD/SEC	RAD/SEC			DEG
0.0800	397.89	1.203	-0.441	4967.2	500.00	1.49	4.45	43.66	0.12	-1.49	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0801	398.39	1.206	-0.442	4967.2	500.00	1.50	4.45	43.23	-0.05	-1.50	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0802	398.89	1.208	-0.442	4967.2	500.00	1.51	4.45	42.79	-0.15	-1.50	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0803	399.38	1.210	-0.442	4967.2	500.00	1.51	4.45	42.39	-0.22	-1.50	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0804	399.88	1.212	-0.443	4967.1	500.00	1.52	4.45	42.05	-0.30	-1.49	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0805	400.38	1.215	-0.443	4967.1	500.00	1.52	4.45	43.13	-0.37	-1.47	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0806	400.87	1.217	-0.444	4967.1	500.00	1.51	4.45	43.42	-0.43	-1.45	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0807	401.37	1.219	-0.444	4967.1	500.00	1.50	4.45	43.79	-0.49	-1.42	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0808	401.87	1.221	-0.444	4967.1	500.00	1.49	4.45	44.19	-0.55	-1.39	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0809	402.36	1.223	-0.444	4967.1	500.00	1.47	4.45	44.60	-0.63	-1.34	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0810	402.86	1.225	-0.445	4967.1	500.00	1.45	4.45	45.00	-0.65	-1.30	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0811	403.36	1.227	-0.445	4967.1	500.00	1.43	4.45	45.35	-0.69	-1.25	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0812	403.85	1.230	-0.445	4967.1	500.00	1.41	4.45	45.53	-0.74	-1.20	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0813	404.35	1.232	-0.445	4967.0	500.00	1.39	4.45	45.92	-0.79	-1.15	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0814	404.85	1.234	-0.445	4967.0	500.00	1.37	4.45	45.93	-0.83	-1.10	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0815	405.34	1.236	-0.445	4967.0	500.00	1.36	4.45	45.95	-0.87	-1.05	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0816	405.84	1.238	-0.445	4967.0	500.00	1.35	4.45	45.87	-0.92	-0.99	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0817	406.34	1.240	-0.445	4967.0	500.00	1.35	4.45	45.79	-0.97	-0.94	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0818	406.83	1.242	-0.445	4967.0	500.00	1.35	4.45	45.65	-1.01	-0.89	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0819	407.33	1.244	-0.445	4967.0	500.00	1.36	4.45	45.54	-1.06	-0.84	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0820	407.83	1.246	-0.445	4967.0	500.00	1.37	4.45	45.45	-1.11	-0.79	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0821	408.32	1.248	-0.445	4967.0	500.00	1.38	4.45	45.42	-1.17	-0.74	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0822	408.82	1.250	-0.445	4967.0	500.00	1.40	4.45	45.46	-1.22	-0.69	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0823	409.31	1.251	-0.445	4966.9	500.00	1.42	4.45	45.57	-1.27	-0.64	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0824	409.81	1.253	-0.445	4966.9	500.00	1.44	4.45	45.77	-1.31	-0.59	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0825	410.31	1.255	-0.445	4966.9	500.00	1.46	4.45	45.99	-1.36	-0.54	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0826	410.80	1.257	-0.444	4966.9	500.00	1.48	4.45	46.25	-1.40	-0.48	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0827	411.30	1.259	-0.444	4966.9	500.00	1.49	4.45	46.55	-1.43	-0.42	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0828	411.80	1.260	-0.444	4966.9	500.00	1.50	4.45	46.83	-1.46	-0.36	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0829	412.29	1.262	-0.444	4966.9	500.00	1.51	4.45	47.07	-1.48	-0.29	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0830	412.79	1.263	-0.444	4966.9	500.00	1.51	4.45	47.26	-1.50	-0.22	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0831	413.29	1.265	-0.444	4966.8	500.00	1.51	4.45	47.37	-1.51	-0.15	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0832	413.78	1.266	-0.443	4966.8	500.00	1.51	4.45	47.37	-1.51	-0.08	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0833	414.28	1.268	-0.443	4966.8	500.00	1.50	4.45	47.26	-1.50	0.00	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0834	414.78	1.269	-0.443	4966.8	500.00	1.49	4.45	47.02	-1.49	0.08	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0835	415.27	1.271	-0.443	4966.8	500.00	1.48	4.45	46.67	-1.47	0.17	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0836	415.77	1.272	-0.442	4966.8	500.00	1.47	4.45	46.21	-1.44	0.25	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0837	416.27	1.273	-0.442	4966.8	500.00	1.45	4.45	45.65	-1.42	0.33	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0838	416.76	1.275	-0.442	4966.8	500.00	1.44	4.45	45.05	-1.39	0.41	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0839	417.26	1.276	-0.442	4966.7	500.00	1.43	4.45	44.42	-1.35	0.49	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0840	417.76	1.277	-0.442	4966.7	500.00	1.43	4.45	43.81	-1.31	0.57	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0841	418.25	1.278	-0.442	4966.7	500.00	1.42	4.45	43.27	-1.27	0.65	-55.	-57.	2332.	-2329.	-0.	0.	1.
0.0842	418.75	1.280	-0.441	4966.7	500.00	1.42	4.45	42.83	-1.22	0.72	-55.	-57.	2332.	-2330.	-0.	0.	1.
0.0843	419.25	1.281	-0.441	4966.7	500.00	1.42	4.45	42.53	-1.18	0.79	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0844	419.74	1.282	-0.441	4966.7	500.00	1.42	4.45	42.39	-1.14	0.84	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0845	420.24	1.283	-0.441	4966.7	500.00	1.42	4.45	42.42	-1.10	0.90	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0846	420.74	1.284	-0.441	4966.7	500.00	1.43	4.45	42.63	-1.06	0.95	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0847	421.23	1.285	-0.441	4966.7	500.00	1.43	4.45	42.99	-1.02	1.00	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0848	421.73	1.286	-0.441	4966.6	500.00	1.43	4.45	43.48	-0.98	1.05	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0849	422.23	1.287	-0.441	4966.6	500.00	1.43	4.45	44.08	-0.94	1.08	-55.	-57.	2333.	-2330.	-0.	0.	1.

FLECHETTE GROUND POINT

T	X	Y	Z	V	P	ALPHA-bar	MACH	PHI	ALPHA	BETA	L-N	L-P	W-N	W-P	S	TAU	K-T
SEC	FT	FT	FT	FT/SEC	RAD/SEC	DEG		DEG	DEG	DEG	1/SEC	1/SEC	RAD/SEC	RAD/SEC			C-G
0.0850	422.72	1.288	-0.441	4966.6	500.00	1.44	4.45	44.76	-0.90	1.12	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0851	423.22	1.289	-0.441	4966.6	500.00	[illegible]	4.45	45.46	-0.85	1.15	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0852	423.72	1.290	-0.441	4966.6	500.00	1.45	4.45	46.15	-0.81	1.19	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0853	424.21	1.291	-0.441	4966.6	500.00	1.43	4.45	46.80	-0.76	1.21	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0854	424.71	1.292	-0.442	4966.6	500.00	1.43	4.45	47.37	-0.71	1.24	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0855	425.21	1.292	-0.442	4966.5	500.00	1.42	4.45	47.82	-0.66	1.26	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0856	425.70	1.293	-0.442	4966.6	500.00	1.42	4.45	48.12	-0.60	1.29	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0857	426.20	1.294	-0.442	4966.6	500.00	1.42	4.45	48.29	-0.53	1.31	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0858	426.70	1.295	-0.443	4966.5	500.00	1.42	4.45	48.23	-0.47	1.34	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0859	427.19	1.296	-0.443	4966.5	500.00	1.41	4.45	48.12	-0.40	1.36	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0860	427.69	1.295	-0.443	4966.5	500.00	1.42	4.45	47.82	-0.32	1.39	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0861	428.19	1.297	-0.444	4966.5	500.00	1.42	4.45	47.42	-0.24	1.40	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0862	428.68	1.298	-0.444	4966.5	500.00	1.42	4.45	46.95	-0.16	1.41	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0863	429.18	1.299	-0.445	4966.5	500.00	1.43	4.45	46.42	-0.08	1.43	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0864	429.67	1.299	-0.445	4966.5	500.00	1.44	4.45	45.89	0.01	1.44	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0865	430.17	1.300	-0.446	4966.5	500.00	1.45	4.45	45.40	0.09	1.45	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0866	430.67	1.301	-0.446	4966.5	500.00	1.46	4.45	44.97	0.18	1.45	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0867	431.16	1.302	-0.447	4966.4	500.00	1.47	4.45	44.62	0.26	1.45	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0868	431.56	1.302	-0.447	4966.4	500.00	1.48	4.45	44.34	0.34	1.44	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0869	432.16	1.303	-0.448	4966.4	500.00	1.49	4.45	44.20	0.42	1.43	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0870	432.65	1.304	-0.449	4966.4	500.00	1.50	4.45	44.14	0.49	1.41	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0871	433.15	1.305	-0.450	4966.4	500.00	1.50	4.45	44.16	0.56	1.39	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0872	433.65	1.306	-0.450	4966.4	500.00	1.50	4.45	44.25	0.63	1.36	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0873	434.14	1.306	-0.451	4966.4	500.00	1.50	4.45	44.40	0.69	1.33	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0874	434.64	1.307	-0.452	4966.4	500.00	1.49	4.45	44.59	0.75	1.29	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0875	435.14	1.308	-0.453	4966.4	500.00	1.48	4.45	44.79	0.81	1.24	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0876	435.63	1.309	-0.454	4966.3	500.00	1.47	4.45	44.97	0.86	1.19	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0877	436.13	1.310	-0.455	4966.3	500.00	1.45	4.45	45.14	0.90	1.14	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0878	436.63	1.311	-0.456	4966.3	500.00	1.44	4.45	45.27	0.95	1.09	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0879	437.12	1.312	-0.457	4966.3	500.00	1.43	4.45	45.35	0.99	1.03	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0880	437.62	1.313	-0.458	4966.3	500.00	1.41	4.45	45.39	1.03	0.97	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0881	438.12	1.314	-0.459	4966.3	500.00	1.40	4.45	45.37	1.06	0.91	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0882	438.61	1.315	-0.460	4966.3	500.00	1.39	4.45	45.32	1.10	0.85	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0883	439.11	1.316	-0.461	4966.3	500.00	1.39	4.45	45.24	1.14	0.79	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0884	439.61	1.317	-0.462	4966.3	500.00	1.39	4.45	45.14	1.17	0.72	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0885	440.10	1.318	-0.463	4966.2	500.00	1.38	4.45	45.06	1.21	0.66	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0886	440.60	1.319	-0.465	4966.2	500.00	1.36	4.45	45.01	1.24	0.60	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0887	441.10	1.320	-0.466	4966.2	500.00	1.39	4.45	45.00	1.28	0.54	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0888	441.59	1.322	-0.467	4966.2	500.00	1.40	4.45	45.05	1.31	0.48	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0889	442.09	1.323	-0.468	4966.2	500.00	1.41	4.45	45.16	1.34	0.42	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0890	442.59	1.324	-0.469	4966.2	500.00	1.42	4.45	45.33	1.37	0.35	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0891	443.08	1.325	-0.471	4966.2	500.00	1.43	4.45	45.56	1.40	0.30	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0892	443.58	1.327	-0.472	4966.2	500.00	1.45	4.45	45.82	1.43	0.24	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0893	444.08	1.328	-0.473	4966.2	500.00	1.45	4.45	46.10	1.45	0.17	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0894	444.57	1.330	-0.474	4966.2	500.00	1.47	4.45	46.39	1.45	0.11	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0895	445.07	1.331	-0.476	4966.1	500.00	1.47	4.45	46.66	1.47	0.04	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0896	445.57	1.333	-0.477	4966.1	500.00	1.48	4.45	46.89	1.49	-0.03	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0897	446.06	1.334	-0.478	4966.1	500.00	1.49	4.45	47.07	1.49	-0.10	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0898	446.56	1.336	-0.479	4966.1	500.00	1.48	4.45	47.16	1.47	-0.17	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0899	447.06	1.337	-0.481	4965.1	500.00	1.46	4.45	47.18	1.45	-0.24	-55.	-57.	2333.	-2330.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.0900	447.55	1.339	-0.482	4966.1	500.00	1.48	4.45	47.03	1.44	-0.31	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0901	448.05	1.341	-0.483	4966.1	500.00	1.47	4.45	46.91	1.42	-0.34	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0902	448.54	1.342	-0.484	4966.1	500.00	1.46	4.45	46.63	1.39	-0.46	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0903	449.04	1.344	-0.485	4966.1	500.00	1.46	4.45	46.27	1.35	-0.54	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0904	449.54	1.346	-0.487	4966.0	500.00	1.45	4.45	45.84	1.32	-0.61	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0905	450.03	1.348	-0.488	4966.0	500.00	1.45	4.45	45.35	1.27	-0.69	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0906	450.53	1.350	-0.489	4966.0	500.00	1.44	4.45	44.90	1.23	-0.76	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0907	451.03	1.351	-0.490	4966.0	500.00	1.44	4.45	44.44	1.18	-0.82	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0908	451.52	1.353	-0.491	4966.0	500.00	1.44	4.45	44.03	1.13	-0.89	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0909	452.02	1.355	-0.492	4966.0	500.00	1.44	4.45	43.69	1.08	-0.95	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0910	452.52	1.357	-0.493	4966.0	500.00	1.44	4.45	43.45	1.02	-1.01	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0911	453.01	1.359	-0.494	4966.0	500.00	1.44	4.45	43.32	0.97	-1.06	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0912	453.51	1.361	-0.495	4966.0	500.00	1.44	4.45	43.30	0.92	-1.11	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0913	454.01	1.363	-0.496	4965.9	500.00	1.44	4.45	43.41	0.86	-1.15	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0914	454.50	1.365	-0.497	4965.9	500.00	1.44	4.45	43.63	0.81	-1.19	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0915	455.00	1.368	-0.498	4965.9	500.00	1.44	4.45	43.94	0.76	-1.23	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0916	455.50	1.370	-0.499	4965.9	500.00	1.44	4.45	44.33	0.70	-1.26	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0917	455.99	1.372	-0.500	4965.9	500.00	1.44	4.45	44.79	0.65	-1.29	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0918	456.49	1.374	-0.501	4965.9	500.00	1.44	4.45	45.25	0.59	-1.31	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0919	456.99	1.376	-0.502	4965.9	500.00	1.43	4.45	45.71	0.54	-1.33	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0920	457.48	1.378	-0.503	4965.9	500.00	1.43	4.45	46.15	0.48	-1.35	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0921	457.98	1.381	-0.503	4965.9	500.00	1.43	4.45	46.53	0.42	-1.36	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0922	458.48	1.383	-0.504	4965.9	500.00	1.42	4.45	46.81	0.35	-1.37	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0923	458.97	1.385	-0.505	4965.8	500.00	1.42	4.45	47.07	0.29	-1.39	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0924	459.47	1.387	-0.505	4965.8	500.00	1.41	4.45	47.19	0.22	-1.40	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0925	459.96	1.389	-0.506	4965.8	500.00	1.41	4.45	47.21	0.15	-1.40	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0926	460.46	1.391	-0.506	4965.8	500.00	1.41	4.45	47.14	0.08	-1.41	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0927	460.96	1.394	-0.507	4965.8	500.00	1.41	4.45	46.98	0.01	-1.41	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0928	461.45	1.396	-0.507	4965.8	500.00	1.42	4.45	46.75	-0.07	-1.41	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0929	461.95	1.398	-0.508	4965.8	500.00	1.42	4.45	46.47	-0.15	-1.41	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0930	462.45	1.400	-0.508	4965.8	500.00	1.43	4.45	46.19	-0.23	-1.41	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0931	462.94	1.403	-0.509	4965.8	500.00	1.44	4.45	45.93	-0.31	-1.40	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0932	463.44	1.405	-0.509	4965.7	500.00	1.44	4.45	45.60	-0.39	-1.39	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0933	463.94	1.407	-0.510	4965.7	500.00	1.45	4.45	45.35	-0.45	-1.38	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0934	464.43	1.409	-0.511	4965.7	500.00	1.46	4.45	45.16	-0.57	-1.36	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0935	464.93	1.411	-0.510	4965.7	500.00	1.47	4.45	45.02	-0.61	-1.34	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0936	465.42	1.413	-0.510	4965.7	500.00	1.48	4.45	44.97	-0.68	-1.31	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0937	465.92	1.416	-0.511	4965.7	500.00	1.49	4.45	44.91	-0.75	-1.28	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0938	466.42	1.418	-0.510	4965.7	500.00	1.49	4.45	44.91	-0.82	-1.24	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0939	466.91	1.420	-0.511	4965.7	500.00	1.49	4.45	44.95	-0.88	-1.20	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0940	467.41	1.422	-0.511	4965.7	500.00	1.48	4.45	45.04	-0.93	-1.15	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0941	467.91	1.424	-0.511	4965.6	500.00	1.48	4.45	45.12	-0.98	-1.10	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0942	468.40	1.426	-0.511	4965.6	500.00	1.47	4.45	45.20	-1.03	-1.05	-55.	-57.	2333	330.	-0.	0.	1.
0.0943	468.90	1.428	-0.511	4965.6	500.00	1.45	4.45	45.27	-1.08	-0.99	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0944	469.40	1.430	-0.511	4965.6	500.00	1.45	4.45	45.31	-1.12	-0.93	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0945	469.89	1.432	-0.511	4965.6	500.00	1.44	4.45	45.33	-1.15	-0.87	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0946	470.39	1.434	-0.511	4965.6	500.00	1.43	4.45	45.31	-1.19	-0.80	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0947	470.88	1.436	-0.510	4965.6	500.00	1.42	4.45	45.25	-1.22	-0.74	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0948	471.38	1.437	-0.510	4965.6	500.00	1.42	4.45	45.13	-1.25	-0.67	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0949	471.88	1.439	-0.510	4965.6	500.00	1.41	4.45	45.04	-1.27	-0.60	-55.	-57.	2333.	-2330.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.0950	472.37	1.441	-0.510	4965.5	500.00	1.40	4.45	44.99	-1.39	-0.53	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0951	472.87	1.443	-0.510	4965.5	500.00	1.40	4.45	44.90	-1.22	-0.46	-55.	-57.	2333.	-2331.	-0.	0.	1.
0.0952	473.37	1.445	-0.510	4965.5	500.00	1.40	4.45	44.86	-1.36	-0.40	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0953	473.86	1.446	-0.510	4965.5	500.00	1.40	4.45	44.81	-1.35	-0.33	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0954	474.36	1.448	-0.509	4965.5	500.00	1.40	4.45	44.83	-1.33	-0.25	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0955	474.85	1.450	-0.509	4965.5	500.00	1.41	4.45	44.91	-1.40	-0.19	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0956	475.35	1.451	-0.509	4965.5	500.00	1.42	4.45	45.02	-1.41	-0.13	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0957	475.85	1.453	-0.509	4965.5	500.00	1.42	4.45	45.19	-1.42	-0.06	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0958	476.34	1.454	-0.509	4965.5	500.00	1.43	4.45	45.40	-1.43	0.00	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0959	476.84	1.456	-0.508	4965.5	500.00	1.44	4.45	45.66	-1.44	0.07	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0960	477.34	1.457	-0.508	4965.4	500.00	1.45	4.45	45.90	-1.44	0.14	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0961	477.83	1.459	-0.508	4965.4	500.00	1.45	4.45	46.16	-1.44	0.20	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0962	478.33	1.460	-0.508	4965.4	500.00	1.46	4.45	46.41	-1.43	0.27	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0963	478.83	1.461	-0.508	4965.4	500.00	1.46	4.45	46.60	-1.42	0.34	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0964	479.32	1.463	-0.507	4965.4	500.00	1.46	4.45	46.75	-1.41	0.40	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0965	479.82	1.464	-0.507	4965.4	500.00	1.46	4.45	46.85	-1.38	0.47	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0966	480.31	1.465	-0.507	4965.4	500.00	1.46	4.45	46.87	-1.35	0.54	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0967	480.81	1.466	-0.507	4965.4	500.00	1.46	4.45	46.82	-1.33	0.61	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0968	481.31	1.467	-0.507	4965.4	500.00	1.46	4.45	46.67	-1.29	0.67	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0969	481.80	1.469	-0.507	4965.3	500.00	1.45	4.45	46.43	-1.25	0.74	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0970	482.30	1.470	-0.507	4965.3	500.00	1.45	4.45	46.22	-1.21	0.81	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0971	482.80	1.471	-0.506	4965.3	500.00	1.45	4.45	45.91	-1.15	0.87	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0972	483.29	1.472	-0.506	4965.3	500.00	1.44	4.45	45.57	-1.10	0.93	-55.	-57.	2333.	-2331.	-0.	0.	1.
0.0973	483.79	1.473	-0.506	4965.3	500.00	1.44	4.45	45.22	-1.05	0.99	-55.	-57.	2333.	-2331.	-0.	0.	1.
0.0974	484.29	1.474	-0.506	4965.3	500.00	1.44	4.45	44.85	-0.99	1.05	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0975	484.78	1.475	-0.506	4965.3	500.00	1.44	4.45	44.53	-0.93	1.10	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0976	485.28	1.476	-0.505	4965.3	500.00	1.44	4.45	44.33	-0.87	1.15	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0977	485.77	1.476	-0.507	4965.3	500.00	1.44	4.45	44.19	-0.81	1.20	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0978	486.27	1.477	-0.507	4965.2	500.00	1.45	4.45	44.23	-0.75	1.24	-55.	-57.	2333.	-2331.	-0.	0.	1.
0.0979	486.77	1.478	-0.507	4965.2	500.00	1.45	4.45	44.09	-0.69	1.27	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0980	487.26	1.479	-0.507	4965.2	500.00	1.45	4.45	44.05	-0.62	1.31	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0981	487.75	1.480	-0.507	4965.2	500.00	1.45	4.45	44.13	-0.56	1.34	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0982	488.26	1.481	-0.507	4965.2	500.00	1.45	4.45	44.37	-0.50	1.36	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0983	488.75	1.481	-0.508	4965.2	500.00	1.45	4.45	44.51	-0.43	1.38	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0984	489.25	1.482	-0.508	4965.2	500.00	1.44	4.45	44.89	-0.37	1.40	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0985	489.75	1.483	-0.508	4965.2	500.00	1.44	4.45	45.19	-0.31	1.41	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0986	490.24	1.484	-0.509	4965.2	500.00	1.44	4.45	45.47	-0.24	1.42	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0987	490.74	1.485	-0.509	4965.1	500.00	1.43	4.45	45.77	-0.18	1.42	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0988	491.23	1.485	-0.510	4965.1	500.00	1.43	4.45	46.01	-0.11	1.42	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0989	491.73	1.486	-0.510	4965.1	500.00	1.42	4.45	46.22	-0.04	1.42	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0990	492.23	1.487	-0.511	4965.1	500.00	1.42	4.45	46.36	0.02	1.42	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0991	492.72	1.488	-0.511	4965.1	500.00	1.42	4.45	46.45	0.09	1.41	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0992	493.22	1.488	-0.512	4965.1	500.00	1.42	4.45	46.47	0.15	1.41	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0993	493.72	1.489	-0.512	4965.1	500.00	1.41	4.45	46.44	0.22	1.40	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0994	494.21	1.490	-0.513	4965.1	500.00	1.42	4.45	46.35	0.30	1.39	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0995	494.71	1.491	-0.514	4965.1	500.00	1.42	4.45	46.24	0.37	1.37	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0996	495.20	1.492	-0.514	4965.1	500.00	1.42	4.45	46.10	0.45	1.35	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0997	495.70	1.492	-0.515	4965.0	500.00	1.43	4.45	45.97	0.52	1.33	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0998	496.20	1.493	-0.516	4965.0	500.00	1.43	4.45	45.78	0.59	1.30	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.0999	496.69	1.494	-0.517	4965.0	500.00	1.44	4.45	45.58	0.65	1.28	-55.	-57.	2333.	-2330.	-0.	0.	1.

FLECHETTE GROUND POI

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	$\bar{\text{ALPHA}}$ DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-M 1/SEC	L-P 1/SEC	W-P RAD/SEC	K-P RAD/SEC	S	TAU	K-T DEG
0.1000	497.19	1.495	-0.518	4965.0	500.00	1.45	4.45	45.52	0.73	1.25	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1001	497.69	1.496	-0.519	4965.0	500.00	1.45	4.45	45.43	0.50	1.21	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1002	498.18	1.497	-0.520	4965.0	500.00	1.45	4.45	45.36	0.55	1.13	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1003	498.68	1.498	-0.521	4965.0	500.00	1.47	4.45	45.33	0.93	1.14	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1004	499.18	1.498	-0.522	4965.0	500.00	1.47	4.45	45.23	0.99	1.09	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1005	499.67	1.499	-0.523	4965.0	500.00	1.47	4.45	45.35	1.04	1.04	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1006	500.17	1.500	-0.524	4964.9	500.00	1.47	4.45	45.33	1.09	0.99	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1007	500.66	1.501	-0.525	4964.9	500.00	1.47	4.45	45.42	1.14	0.93	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1008	501.16	1.502	-0.526	4964.9	500.00	1.47	4.45	45.45	1.18	0.38	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1009	501.65	1.504	-0.527	4964.9	500.00	1.46	4.45	45.47	1.22	0.81	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1010	502.15	1.505	-0.528	4964.9	500.00	1.46	4.45	45.49	1.25	0.75	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1011	502.65	1.506	-0.529	4964.9	500.00	1.45	4.45	45.45	1.28	0.68	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1012	503.15	1.507	-0.530	4964.9	500.00	1.45	4.45	45.42	1.31	0.61	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1013	503.64	1.508	-0.532	4964.9	500.00	1.44	4.45	45.35	1.33	0.54	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1014	504.14	1.509	-0.533	4964.9	500.00	1.43	4.45	45.27	1.35	0.47	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1015	504.64	1.511	-0.534	4964.8	500.00	1.43	4.45	45.17	1.37	0.40	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1016	505.13	1.512	-0.535	4964.8	500.00	1.42	4.45	45.06	1.39	0.33	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1017	505.63	1.513	-0.536	4964.8	500.00	1.42	4.45	44.96	1.40	0.25	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1018	506.12	1.515	-0.538	4964.8	500.00	1.42	4.45	44.93	1.40	0.18	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1019	506.62	1.516	-0.539	4964.8	500.00	1.41	4.45	44.82	1.41	0.11	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1020	507.12	1.517	-0.540	4964.8	500.00	1.42	4.45	44.80	1.42	0.04	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1021	507.61	1.519	-0.541	4964.8	500.00	1.42	4.45	44.82	1.42	-0.03	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1022	508.11	1.520	-0.543	4964.8	500.00	1.42	4.45	44.83	1.42	-0.10	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1023	508.61	1.522	-0.544	4964.8	500.00	1.42	4.45	44.93	1.41	-0.17	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1024	509.10	1.524	-0.545	4964.7	500.00	1.43	4.45	45.13	1.41	-0.24	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1025	509.60	1.525	-0.546	4964.7	500.00	1.43	4.45	45.31	1.40	-0.30	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1026	510.09	1.527	-0.548	4964.7	500.00	1.44	4.45	45.51	1.39	-0.37	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1027	510.59	1.528	-0.549	4964.7	500.00	1.44	4.45	45.72	1.37	-0.44	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1028	511.09	1.530	-0.550	4964.7	500.00	1.44	4.45	45.93	1.33	-0.50	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1029	511.58	1.532	-0.551	4964.7	500.00	1.45	4.45	46.13	1.33	-0.56	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1030	512.08	1.534	-0.552	4964.7	500.00	1.45	4.45	46.30	1.31	-0.63	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1031	512.58	1.536	-0.554	4964.7	500.00	1.45	4.45	46.43	1.28	-0.69	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1032	513.07	1.538	-0.555	4964.7	500.00	1.45	4.45	46.51	1.24	-0.75	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1033	513.57	1.539	-0.556	4964.6	500.00	1.45	4.45	46.54	1.20	-0.81	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1034	514.07	1.541	-0.557	4964.6	500.00	1.45	4.45	46.52	1.15	-0.87	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1035	514.56	1.543	-0.558	4964.6	500.00	1.45	4.45	46.43	1.11	-0.93	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1036	515.06	1.545	-0.559	4964.6	500.00	1.45	4.45	46.29	1.05	-0.98	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1037	515.55	1.547	-0.560	4964.6	500.00	1.44	4.45	46.11	1.01	-1.04	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1038	516.05	1.549	-0.561	4964.6	500.00	1.44	4.45	45.90	0.95	-1.09	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1039	516.55	1.551	-0.562	4964.6	500.00	1.44	4.45	45.65	0.87	-1.14	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1040	517.04	1.553	-0.563	4964.6	500.00	1.44	4.45	45.41	0.82	-1.19	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1041	517.54	1.556	-0.564	4964.6	500.00	1.44	4.45	45.19	0.75	-1.23	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1042	518.04	1.558	-0.565	4964.6	500.00	1.44	4.45	44.95	0.67	-1.27	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1043	518.53	1.560	-0.566	4964.5	500.00	1.45	4.45	44.78	0.53	-1.30	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1044	519.03	1.562	-0.567	4964.5	500.00	1.45	4.45	44.64	0.55	-1.34	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1045	519.53	1.564	-0.567	4964.5	500.00	1.45	4.45	44.55	0.43	-1.36	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1046	520.02	1.566	-0.568	4964.5	500.00	1.45	4.45	44.52	0.32	-1.39	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1047	520.52	1.568	-0.569	4964.5	500.00	1.45	4.45	44.54	0.35	-1.41	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1048	521.01	1.571	-0.570	4964.5	500.00	1.45	4.45	44.61	0.28	-1.42	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1049	521.51	1.573	-0.577	4964.5	500.00	1.45	4.45	44.72	0.21	-1.43	-55.	-57.	2333.	-2330.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA-bar DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.1050	522.01	1.575	-0.571	4964.5	500.00	1.45	4.45	44.87	0.14	-1.47	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1051	522.50	1.577	-0.571	4964.5	500.00	1.44	4.45	45.03	0.07	-1.44	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1052	523.00	1.580	-0.572	4964.4	500.00	1.44	4.45	45.21	0.01	-1.44	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1053	523.50	1.582	-0.572	4964.4	500.00	1.44	4.45	45.39	-0.06	-1.44	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1054	523.99	1.584	-0.573	4964.4	500.00	1.43	4.45	45.56	-0.13	-1.43	-55.	-57.	2333.	-2330.	-0.	0.	1.
0.1055	524.49	1.586	-0.573	4964.4	500.00	1.43	4.45	45.71	-0.20	-1.42	-55.	-57.	2333.	-2331.	-0.	0.	1.
0.1056	524.99	1.588	-0.573	4964.4	500.00	1.43	4.45	45.34	-0.26	-1.40	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1057	525.48	1.591	-0.574	4964.4	500.00	1.42	4.45	45.33	-0.33	-1.39	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1058	525.98	1.593	-0.574	4964.4	500.00	1.42	4.45	45.39	-0.40	-1.37	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1059	526.47	1.595	-0.575	4964.4	500.00	1.42	4.45	45.00	-0.46	-1.36	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1060	526.97	1.597	-0.575	4964.4	500.00	1.42	4.45	45.09	-0.53	-1.32	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1061	527.47	1.599	-0.575	4964.3	500.00	1.42	4.45	45.35	-0.60	-1.29	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1062	527.96	1.601	-0.575	4964.3	500.00	1.42	4.45	45.39	-0.66	-1.25	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1063	528.46	1.604	-0.576	4964.3	500.00	1.42	4.45	45.82	-0.73	-1.22	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1064	528.96	1.606	-0.576	4964.3	500.00	1.43	4.45	45.74	-0.79	-1.19	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1065	529.45	1.608	-0.576	4964.3	500.00	1.43	4.45	45.57	-0.85	-1.15	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1066	529.95	1.610	-0.575	4964.3	500.00	1.44	4.45	45.51	-0.91	-1.11	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1067	530.44	1.612	-0.576	4964.3	500.00	1.44	4.45	45.55	-0.97	-1.07	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1068	530.94	1.614	-0.576	4964.3	500.00	1.45	4.45	45.54	-1.03	-1.02	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1069	531.44	1.616	-0.576	4964.2	500.00	1.45	4.45	45.52	-1.08	-0.97	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1070	531.93	1.618	-0.576	4964.2	500.00	1.46	4.45	45.53	-1.13	-0.92	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1071	532.43	1.620	-0.576	4964.2	500.00	1.46	4.45	45.56	-1.19	-0.86	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1072	532.93	1.622	-0.576	4964.2	500.00	1.46	4.45	45.57	-1.22	-0.80	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1073	533.42	1.624	-0.576	4964.2	500.00	1.46	4.45	45.59	-1.25	-0.74	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1074	533.92	1.625	-0.576	4964.2	500.00	1.46	4.45	45.61	-1.30	-0.68	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1075	534.42	1.627	-0.575	4964.2	500.00	1.46	4.45	45.63	-1.33	-0.61	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1076	534.91	1.629	-0.575	4964.2	500.00	1.45	4.45	45.52	-1.35	-0.54	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1077	535.41	1.631	-0.575	4964.2	500.00	1.45	4.45	45.40	-1.37	-0.47	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1078	535.90	1.632	-0.575	4964.1	500.00	1.45	4.45	45.35	-1.39	-0.40	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1079	536.40	1.634	-0.575	4964.1	500.00	1.45	4.45	45.50	-1.41	-0.33	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1080	536.90	1.636	-0.575	4964.1	500.00	1.44	4.45	45.42	-1.42	-0.26	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1081	537.39	1.637	-0.574	4964.1	500.00	1.44	4.45	45.33	-1.43	-0.18	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1082	537.89	1.639	-0.574	4964.1	500.00	1.43	4.45	45.23	-1.42	-0.11	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1083	538.39	1.640	-0.574	4964.1	500.00	1.43	4.45	45.13	-1.43	-0.03	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1084	538.88	1.642	-0.574	4964.1	500.00	1.43	4.45	45.03	-1.43	0.03	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1085	539.38	1.643	-0.574	4964.1	500.00	1.43	4.45	44.96	-1.42	0.11	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1086	539.88	1.645	-0.573	4964.1	500.00	1.43	4.45	44.91	-1.41	0.19	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1087	540.37	1.646	-0.573	4964.1	500.00	1.43	4.45	44.89	-1.40	0.26	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1088	540.87	1.648	-0.573	4964.0	500.00	1.43	4.45	44.90	-1.39	0.33	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1089	541.36	1.649	-0.573	4964.0	500.00	1.43	4.45	44.96	-1.37	0.39	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1090	541.86	1.650	-0.573	4964.0	500.00	1.43	4.45	45.02	-1.35	0.46	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1091	542.36	1.651	-0.572	4964.0	500.00	1.43	4.45	45.13	-1.33	0.53	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1092	542.85	1.653	-0.572	4964.0	500.00	1.43	4.45	45.27	-1.31	0.59	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1093	543.35	1.654	-0.572	4964.0	500.00	1.44	4.45	45.43	-1.28	0.65	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1094	543.85	1.655	-0.572	4964.0	500.00	1.44	4.45	45.59	-1.25	0.71	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1095	544.34	1.655	-0.572	4964.0	500.00	1.44	4.45	45.75	-1.22	0.77	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1096	544.84	1.657	-0.572	4964.0	500.00	1.44	4.45	45.91	-1.18	0.83	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1097	545.33	1.658	-0.572	4963.9	500.00	1.44	4.45	46.04	-1.14	0.89	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1098	545.83	1.659	-0.572	4963.9	500.00	1.44	4.45	46.15	-1.09	0.94	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1099	546.33	1.660	-0.572	4963.9	500.00	1.44	4.45	46.22	-1.05	0.99	-55.	-57.	2334.	-2331.	-0.	0.	1.

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T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA~ DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-1 RAD/SEC	W-P RAD/SEC	S.	TAU	K-T DEG
0.1100	546.82	1.661	-0.572	4963.9	500.00	1.44	4.45	46.25	-1.00	1.04	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1101	547.32	1.662	-0.572	4963.9	500.00	1.44	4.45	46.24	-0.94	1.09	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1102	547.82	1.663	-0.572	4963.9	500.00	1.44	4.45	46.17	-0.89	1.14	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1103	548.31	1.664	-0.572	4963.9	500.00	1.44	4.45	46.10	-0.83	1.19	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1104	548.81	1.665	-0.572	4963.9	500.00	1.44	4.45	45.98	-0.76	1.22	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1105	549.31	1.666	-0.572	4963.9	500.00	1.44	4.45	45.85	-0.70	1.26	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1106	549.80	1.667	-0.572	4963.9	500.00	1.44	4.45	45.62	-0.63	1.29	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1107	550.30	1.667	-0.573	4963.8	500.00	1.44	4.45	45.51	-0.56	1.33	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1108	550.79	1.668	-0.573	4963.8	500.00	1.44	4.45	45.35	-0.49	1.36	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1109	551.29	1.669	-0.573	4963.8	500.00	1.44	4.45	45.21	-0.42	1.39	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1110	551.79	1.670	-0.573	4963.8	500.00	1.45	4.45	45.08	-0.35	1.40	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1111	552.28	1.671	-0.574	4963.8	500.00	1.45	4.45	44.93	-0.28	1.42	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1112	552.78	1.671	-0.574	4963.8	500.00	1.45	4.45	44.92	-0.20	1.43	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1113	553.28	1.672	-0.575	4963.8	500.00	1.45	4.45	44.89	-0.13	1.44	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1114	553.77	1.673	-0.575	4963.8	500.00	1.45	4.45	44.90	-0.05	1.45	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1115	554.27	1.674	-0.576	4963.7	500.00	1.45	4.45	44.93	0.01	1.45	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1116	554.77	1.674	-0.576	4963.7	500.00	1.45	4.45	44.99	0.09	1.45	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1117	555.26	1.675	-0.577	4963.7	500.00	1.45	4.45	45.03	0.15	1.44	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1118	555.76	1.676	-0.577	4963.7	500.00	1.45	4.45	45.17	0.22	1.43	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1119	556.25	1.677	-0.578	4963.7	500.00	1.44	4.45	45.23	0.29	1.41	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1120	556.75	1.677	-0.579	4963.7	500.00	1.44	4.45	45.33	0.35	1.39	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1121	557.25	1.678	-0.579	4963.7	500.00	1.44	4.45	45.47	0.43	1.37	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1122	557.74	1.679	-0.580	4963.7	500.00	1.43	4.45	45.55	0.49	1.35	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1123	558.24	1.680	-0.581	4963.7	500.00	1.43	4.45	45.67	0.55	1.32	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1124	558.74	1.681	-0.582	4963.7	500.00	1.43	4.45	45.67	0.62	1.29	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1125	559.23	1.682	-0.583	4963.6	500.00	1.43	4.45	45.70	0.69	1.25	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1126	559.73	1.682	-0.583	4963.6	500.00	1.42	4.45	45.71	0.74	1.22	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1127	560.23	1.683	-0.584	4963.6	500.00	1.42	4.45	45.73	0.80	1.19	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1128	560.72	1.684	-0.585	4963.6	500.00	1.42	4.45	45.69	0.86	1.14	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1129	561.22	1.685	-0.586	4963.5	500.00	1.42	4.45	45.66	0.91	1.09	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1130	561.71	1.686	-0.587	4963.5	500.00	1.43	4.45	45.63	0.97	1.05	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1131	562.21	1.687	-0.588	4963.5	500.00	1.43	4.45	45.60	1.02	1.00	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1132	562.71	1.688	-0.589	4963.5	500.00	1.43	4.45	45.57	1.07	0.95	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1133	563.20	1.689	-0.590	4963.5	500.00	1.44	4.45	45.35	1.12	0.89	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1134	563.70	1.690	-0.592	4963.5	500.00	1.44	4.45	45.34	1.17	0.84	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1135	564.20	1.691	-0.593	4963.5	500.00	1.44	4.45	45.56	1.21	0.79	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1136	564.69	1.692	-0.594	4963.5	500.00	1.45	4.45	45.58	1.25	0.72	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1137	565.19	1.693	-0.595	4963.5	500.00	1.45	4.45	45.60	1.29	0.66	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1138	565.68	1.695	-0.596	4963.5	500.00	1.45	4.45	45.63	1.32	0.60	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1139	566.18	1.696	-0.597	4963.5	500.00	1.45	4.45	45.66	1.35	0.53	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1140	566.68	1.697	-0.599	4963.5	500.00	1.45	4.45	45.68	1.39	0.46	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1141	567.17	1.698	-0.600	4963.5	500.00	1.45	4.45	45.70	1.40	0.39	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1142	567.67	1.700	-0.601	4963.5	500.00	1.45	4.45	45.70	1.42	0.32	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1143	568.17	1.701	-0.602	4963.5	500.00	1.45	4.45	45.67	1.43	0.25	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1144	568.66	1.702	-0.603	4963.4	500.00	1.45	4.45	45.65	1.44	0.18	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1145	569.16	1.704	-0.605	4963.4	500.00	1.45	4.45	45.61	1.44	0.10	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1146	569.66	1.705	-0.606	4963.4	500.00	1.44	4.45	45.55	1.44	0.03	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1147	570.15	1.707	-0.607	4963.4	500.00	1.44	4.45	45.49	1.44	-0.04	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1148	570.65	1.709	-0.609	4963.4	500.00	1.44	4.45	45.39	1.43	-0.12	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1149	571.14	1.710	-0.610	4963.4	500.00	1.44	4.45	45.30	1.42	-0.19	-55.	-57.	2334.	-2331.	-0.	0.	1.

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T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA-bar DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-M 1/SEC	L-P 1/SEC	W-R RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.1150	571.64	1.711	-0.611	4963.4	500.00	1.43	4.45	45.21	1.41	-0.26	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1151	572.14	1.713	-0.612	4963.4	500.00	1.43	4.45	45.14	1.39	-0.33	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1152	572.63	1.715	-0.613	4963.4	500.00	1.43	4.45	45.07	1.37	-0.41	-55.	-57.	2335.	-2331.	-0.	0.	1.
0.1153	573.13	1.714	-0.615	4963.3	500.00	1.43	4.45	45.02	1.35	-0.47	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1154	573.62	1.718	-0.616	4963.3	500.00	1.43	4.45	45.00	1.33	-0.54	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1155	574.12	1.720	-0.617	4963.3	500.00	1.43	4.45	45.01	1.30	-0.61	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1156	574.62	1.722	-0.618	4963.3	500.00	1.43	4.45	45.04	1.27	-0.67	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1157	575.11	1.724	-0.619	4963.3	500.00	1.43	4.45	45.09	1.23	-0.73	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1158	575.61	1.725	-0.620	4963.3	500.00	1.43	4.45	45.17	1.20	-0.79	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1159	576.10	1.727	-0.622	4963.3	500.00	1.44	4.45	45.27	1.15	-0.85	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1160	576.60	1.729	-0.623	4963.3	500.00	1.44	4.45	45.39	1.12	-0.91	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1161	577.10	1.731	-0.624	4963.3	500.00	1.44	4.45	45.51	1.07	-0.96	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1162	577.59	1.733	-0.625	4963.2	500.00	1.44	4.45	45.63	1.02	-1.01	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1163	578.09	1.735	-0.626	4963.2	500.00	1.44	4.45	45.74	0.95	-1.05	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1164	578.58	1.737	-0.627	4963.2	500.00	1.44	4.45	45.85	0.92	-1.10	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1165	579.08	1.739	-0.628	4963.2	500.00	1.44	4.45	45.92	0.87	-1.15	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1166	579.58	1.741	-0.629	4963.2	500.00	1.44	4.45	45.98	0.81	-1.19	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1167	580.07	1.743	-0.630	4963.2	500.00	1.44	4.45	46.01	0.75	-1.23	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1168	580.57	1.746	-0.631	4963.2	500.00	1.44	4.45	46.01	0.69	-1.26	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1169	581.07	1.748	-0.631	4963.2	500.00	1.44	4.45	45.98	0.62	-1.29	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1170	581.56	1.750	-0.632	4963.2	500.00	1.44	4.45	45.93	0.55	-1.32	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1171	582.06	1.752	-0.633	4963.1	500.00	1.44	4.45	45.85	0.49	-1.35	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1172	582.55	1.754	-0.634	4963.1	500.00	1.44	4.45	45.76	0.42	-1.39	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1173	583.05	1.756	-0.634	4963.1	500.00	1.44	4.45	45.66	0.35	-1.40	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1174	583.55	1.759	-0.635	4963.1	500.00	1.44	4.45	45.55	0.27	-1.41	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1175	584.04	1.761	-0.636	4963.1	500.00	1.44	4.45	45.45	0.20	-1.43	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1176	584.54	1.763	-0.635	4963.1	500.00	1.44	4.45	45.36	0.13	-1.44	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1177	585.03	1.765	-0.637	4963.1	500.00	1.44	4.45	45.28	0.05	-1.44	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1178	585.53	1.768	-0.637	4963.1	500.00	1.45	4.45	45.21	-0.02	-1.45	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1179	586.03	1.770	-0.638	4963.1	500.00	1.45	4.45	45.17	-0.09	-1.44	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1180	586.52	1.772	-0.637	4963.0	500.00	1.45	4.45	45.15	-0.17	-1.44	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1181	587.02	1.774	-0.639	4963.0	500.00	1.45	4.45	45.14	-0.23	-1.43	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1182	587.51	1.776	-0.639	4963.0	500.00	1.45	4.45	45.15	-0.31	-1.41	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1183	588.01	1.779	-0.640	4963.0	500.00	1.45	4.45	45.19	-0.38	-1.40	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1184	588.51	1.781	-0.640	4963.0	500.00	1.45	4.45	45.23	-0.45	-1.38	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1185	589.00	1.783	-0.640	4963.0	500.00	1.44	4.45	45.29	-0.51	-1.35	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1186	589.50	1.785	-0.640	4963.0	500.00	1.44	4.45	45.36	-0.59	-1.32	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1187	590.00	1.787	-0.641	4963.0	500.00	1.44	4.45	45.40	-0.66	-1.29	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1188	590.49	1.789	-0.641	4963.0	500.00	1.44	4.45	45.44	-0.73	-1.25	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1189	590.99	1.792	-0.641	4962.9	500.00	1.44	4.45	45.49	-0.78	-1.22	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1190	591.49	1.794	-0.641	4962.9	500.00	1.43	4.45	45.52	-0.82	-1.18	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1191	591.98	1.796	-0.641	4962.9	500.00	1.43	4.45	45.54	-0.88	-1.13	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1192	592.48	1.799	-0.641	4962.9	500.00	1.43	4.45	45.55	-0.93	-1.09	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1193	592.97	1.800	-0.641	4962.9	500.00	1.43	4.45	45.55	-0.98	-1.04	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1194	593.47	1.802	-0.641	4962.9	500.00	1.43	4.45	45.54	-1.03	-0.99	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1195	593.96	1.804	-0.641	4962.9	500.00	1.43	4.45	45.53	-1.08	-0.93	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1196	594.46	1.806	-0.641	4962.9	500.00	1.43	4.45	45.52	-1.13	-0.88	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1197	594.96	1.808	-0.641	4962.9	500.00	1.43	4.45	45.51	-1.17	-0.82	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1198	595.45	1.810	-0.641	4962.9	500.00	1.43	4.45	45.51	-1.21	-0.76	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1199	595.95	1.811	-0.641	4962.8	500.00	1.43	4.45	45.51	-1.25	-0.70	-55.	-57.	2334.	-2331.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA~ DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	F-T DEG
0.1200	596.44	1.813	-0.641	4962.8	500.00	1.44	4.45	45.51	-1.29	-0.66	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1201	596.94	1.815	-0.641	4962.8	500.00	1.44	4.45	45.53	-1.32	-0.59	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1202	597.44	1.817	-0.641	4962.8	500.00	1.44	4.45	45.55	-1.35	-0.51	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1203	597.93	1.819	-0.640	4962.8	500.00	1.44	4.45	45.58	-1.37	-0.44	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1204	598.43	1.820	-0.640	4962.8	500.00	1.44	4.45	45.61	-1.39	-0.39	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1205	598.92	1.822	-0.640	4962.8	500.00	1.45	4.45	45.64	-1.41	-0.31	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1206	599.42	1.824	-0.640	4962.8	500.00	1.45	4.45	45.67	-1.43	-0.24	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1207	599.92	1.825	-0.640	4962.8	500.00	1.45	4.45	45.70	-1.44	-0.17	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1208	600.41	1.827	-0.639	4962.7	500.00	1.45	4.45	45.71	-1.46	-0.09	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1209	600.91	1.828	-0.639	4962.7	500.00	1.45	4.45	45.71	-1.45	-0.02	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1210	601.41	1.830	-0.639	4962.7	500.00	1.45	4.45	45.70	-1.45	0.05	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1211	601.90	1.831	-0.639	4962.7	500.00	1.45	4.45	45.67	-1.44	0.12	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1212	602.40	1.833	-0.639	4962.7	500.00	1.44	4.45	45.63	-1.43	0.21	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1213	602.89	1.834	-0.638	4962.7	500.00	1.44	4.45	45.58	-1.42	0.27	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1214	603.39	1.835	-0.638	4962.7	500.00	1.44	4.45	45.51	-1.40	0.34	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1215	603.89	1.837	-0.638	4962.7	500.00	1.44	4.45	45.44	-1.38	0.41	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1216	604.38	1.838	-0.638	4962.7	500.00	1.44	4.45	45.37	-1.34	0.46	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1217	604.88	1.839	-0.638	4962.6	500.00	1.44	4.45	45.30	-1.33	0.55	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1218	605.37	1.840	-0.638	4962.6	500.00	1.44	4.45	45.23	-1.30	0.62	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1219	605.87	1.841	-0.637	4962.6	500.00	1.44	4.45	45.18	-1.26	0.68	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1220	606.37	1.843	-0.637	4962.5	500.00	1.44	4.45	45.15	-1.23	0.76	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1221	606.86	1.844	-0.637	4962.5	500.00	1.44	4.45	45.17	-1.19	0.81	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1222	607.36	1.845	-0.637	4962.6	500.00	1.44	4.45	45.12	-1.15	0.86	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1223	607.85	1.846	-0.637	4962.6	500.00	1.44	4.45	45.14	-1.10	0.92	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1224	608.35	1.847	-0.637	4962.6	500.00	1.44	4.45	45.17	-1.06	0.97	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1225	608.85	1.848	-0.637	4962.6	500.00	1.44	4.45	45.23	-1.01	1.02	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1226	609.34	1.849	-0.637	4962.5	500.00	1.44	4.45	45.30	-0.96	1.07	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1227	609.84	1.850	-0.637	4962.5	500.00	1.44	4.45	45.38	-0.90	1.12	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1228	610.33	1.851	-0.637	4962.5	500.00	1.44	4.45	45.46	-0.85	1.16	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1229	610.83	1.851	-0.637	4962.5	500.00	1.44	4.45	45.55	-0.79	1.20	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1230	611.33	1.852	-0.637	4962.5	500.00	1.44	4.44	45.63	-0.73	1.24	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1231	611.82	1.853	-0.638	4962.5	500.00	1.44	4.44	45.70	-0.67	1.27	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1232	612.32	1.854	-0.638	4962.5	500.00	1.44	4.44	45.76	-0.61	1.30	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1233	612.82	1.855	-0.638	4962.5	500.00	1.44	4.44	45.80	-0.55	1.33	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1234	613.31	1.855	-0.638	4962.4	500.00	1.44	4.44	45.82	-0.49	1.35	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1235	613.81	1.856	-0.639	4962.4	500.00	1.44	4.44	45.83	-0.41	1.38	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1236	614.30	1.857	-0.639	4962.4	500.00	1.44	4.44	45.82	-0.31	1.40	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1237	614.80	1.858	-0.639	4962.4	500.00	1.44	4.44	45.79	-0.27	1.41	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1238	615.30	1.859	-0.640	4962.4	500.00	1.44	4.44	45.74	-0.18	1.42	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1239	615.79	1.860	-0.640	4962.4	500.00	1.44	4.44	45.69	-0.12	1.43	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1240	616.29	1.860	-0.641	4962.4	500.00	1.44	4.44	45.62	-0.05	1.44	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1241	616.78	1.861	-0.641	4962.4	500.00	1.44	4.44	45.55	0.03	1.44	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1242	617.28	1.862	-0.642	4962.4	500.00	1.44	4.44	45.50	0.11	1.44	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1243	617.78	1.863	-0.642	4962.4	500.00	1.44	4.44	45.44	0.17	1.43	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1244	618.27	1.863	-0.643	4962.3	500.00	1.44	4.44	45.39	0.24	1.42	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1245	618.77	1.864	-0.644	4962.3	500.00	1.44	4.44	45.35	0.32	1.41	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1246	619.26	1.865	-0.644	4962.3	500.00	1.44	4.44	45.32	0.39	1.39	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1247	619.76	1.866	-0.645	4962.3	500.00	1.45	4.44	45.31	0.46	1.37	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1248	620.25	1.866	-0.646	4962.3	500.00	1.45	4.44	45.31	0.53	1.35	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1249	620.75	1.867	-0.647	4962.3	500.00	1.45	4.44	45.31	0.60	1.32	-55.	-57.	2334.	-2331.	-0.	0.	1.

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T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA-BAR DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.1250	621.25	1.868	-0.647	4962.3	500.00	1.45	4.44	45.33	0.66	1.29	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1251	621.75	1.869	-0.648	4962.3	500.00	1.44	4.44	45.35	0.72	1.25	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1252	622.24	1.870	-0.649	4962.3	500.00	1.44	4.44	45.38	0.78	1.21	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1253	622.74	1.871	-0.650	4962.2	500.00	1.44	4.44	45.40	0.84	1.17	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1254	623.23	1.872	-0.651	4962.2	500.00	1.44	4.44	45.43	0.89	1.13	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1255	623.73	1.873	-0.652	4962.2	500.00	1.44	4.44	45.45	0.95	1.09	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1256	624.23	1.874	-0.653	4962.2	500.00	1.44	4.44	45.45	1.00	1.03	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1257	624.72	1.875	-0.654	4962.2	500.00	1.44	4.44	45.47	1.05	0.95	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1258	625.22	1.876	-0.655	4962.2	500.00	1.43	4.44	45.47	1.10	0.33	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1259	625.71	1.877	-0.656	4962.2	500.00	1.43	4.44	45.47	1.14	0.87	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1260	626.21	1.878	-0.657	4962.2	500.00	1.43	4.44	45.47	1.18	0.81	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1261	626.71	1.879	-0.658	4962.2	500.00	1.43	4.44	45.46	1.22	0.75	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1262	627.20	1.880	-0.663	4962.2	500.00	1.43	4.44	45.45	1.25	0.69	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1263	627.70	1.881	-0.661	4962.1	500.00	1.43	4.44	45.45	1.29	0.62	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1264	628.19	1.882	-0.662	4962.1	500.00	1.43	4.44	45.43	1.32	0.56	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1265	628.69	1.883	-0.653	4962.1	500.00	1.43	4.44	45.45	1.35	0.49	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1266	629.19	1.885	-0.656	4962.1	500.00	1.43	4.44	45.45	1.37	0.43	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1267	629.68	1.886	-0.666	4962.1	500.00	1.44	4.44	45.48	1.39	0.36	-55.	-57.	2334.	-2331.	-0.	0.	1.
0.1268	630.18	1.887	-0.667	4962.1	500.00	1.44	4.44	45.50	1.41	0.29	-55.	-57.	2334.	-2332.	-0.	0.	1.
0.1269	630.67	1.889	-0.663	4962.1	500.00	1.44	4.44	45.53	1.42	0.22	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1270	631.17	1.890	-0.669	4962.1	500.00	1.44	4.44	45.56	1.43	0.15	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1271	631.67	1.891	-0.670	4962.1	500.00	1.44	4.44	45.59	1.44	0.08	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1272	632.16	1.893	-0.672	4962.0	500.00	1.44	4.44	45.62	1.44	0.01	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1273	632.65	1.894	-0.673	4962.0	500.00	1.44	4.44	45.65	1.44	-0.07	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1274	633.15	1.896	-0.674	4962.0	500.00	1.44	4.44	45.67	1.44	-0.14	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1275	633.65	1.898	-0.675	4962.0	500.00	1.44	4.44	45.69	1.43	-0.21	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1276	634.15	1.899	-0.677	4962.0	500.00	1.44	4.44	45.69	1.42	-0.28	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1277	634.64	1.901	-0.678	4962.0	500.00	1.44	4.44	45.68	1.40	-0.35	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1278	635.14	1.902	-0.679	4962.0	500.00	1.44	4.44	45.66	1.38	-0.42	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1279	635.64	1.904	-0.680	4962.0	500.00	1.44	4.44	45.63	1.36	-0.49	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1280	636.13	1.905	-0.682	4962.0	500.00	1.44	4.44	45.59	1.33	-0.55	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1281	636.63	1.908	-0.683	4961.9	500.00	1.44	4.44	45.54	1.30	-0.62	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1282	637.12	1.910	-0.684	4961.9	500.00	1.44	4.44	45.48	1.26	-0.69	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1283	637.62	1.911	-0.685	4961.9	500.00	1.44	4.44	45.42	1.23	-0.75	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1284	638.12	1.913	-0.686	4961.9	500.00	1.44	4.44	45.37	1.19	-0.81	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1285	638.61	1.915	-0.687	4961.9	500.00	1.44	4.44	45.32	1.14	-0.87	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1286	639.11	1.917	-0.688	4961.9	500.00	1.44	4.44	45.28	1.10	-0.93	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1287	639.60	1.919	-0.689	4961.9	500.00	1.44	4.44	45.24	1.05	-0.98	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1288	640.10	1.921	-0.690	4961.9	500.00	1.44	4.44	45.23	1.00	-1.03	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1289	640.60	1.923	-0.692	4961.9	500.00	1.44	4.44	45.22	0.94	-1.08	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1290	641.09	1.925	-0.692	4961.9	500.00	1.44	4.44	45.23	0.89	-1.13	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1291	641.59	1.927	-0.693	4961.9	500.00	1.44	4.44	45.25	0.83	-1.17	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1292	642.08	1.929	-0.694	4961.8	500.00	1.44	4.44	45.29	0.77	-1.21	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1293	642.58	1.931	-0.695	4961.8	500.00	1.44	4.44	45.33	0.71	-1.25	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1294	643.08	1.934	-0.696	4961.8	500.00	1.44	4.44	45.37	0.65	-1.28	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1295	643.57	1.936	-0.697	4961.8	500.00	1.44	4.44	45.44	0.59	-1.31	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1296	644.07	1.938	-0.698	4961.8	500.00	1.44	4.44	45.50	0.52	-1.34	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1297	644.57	1.940	-0.699	4961.8	500.00	1.44	4.44	45.56	0.46	-1.36	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1298	645.06	1.942	-0.699	4961.8	500.00	1.44	4.44	45.61	0.39	-1.39	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1299	645.56	1.944	-0.700	4961.7	500.00	1.44	4.44	45.65	0.32	-1.40	-55.	-57.	2335.	-2332.	-0.	0.	1.

FLECHETTE GROUND POINT

T	X	Y	Z	V	P	ALPHA	MACH	PHI	ALPHA	BETA	L-N	L-P	W-N	W-P	S	TAU	K-J
SEC	FT	FT	FT	FT/SEC	RAD/SEC	DEG		DEG	DEG	DEG	1/SEC	1/SEC	RAD/SEC	RAD/SEC			DEG
0.1300	645.05	1.947	-0.701	4961.7	500.00	1.44	4.44	45.58	0.23	-1.41	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1301	646.55	1.949	-0.701	4961.7	500.00	1.44	4.44	45.57	0.19	-1.42	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1302	647.05	1.951	-0.702	4961.7	500.00	1.43	4.44	45.70	0.11	-1.43	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1303	647.54	1.953	-0.702	4961.7	500.00	1.43	4.44	45.69	0.04	-1.43	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1304	648.04	1.955	-0.703	4961.7	500.00	1.43	4.44	45.55	-0.04	-1.43	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1305	648.53	1.958	-0.703	4961.7	500.00	1.44	4.44	45.65	-0.11	-1.43	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1306	649.03	1.960	-0.704	4961.7	500.00	1.44	4.44	45.62	-0.17	-1.42	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1307	649.53	1.962	-0.704	4961.6	500.00	1.44	4.44	45.59	-0.25	-1.41	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1308	650.02	1.964	-0.705	4961.6	500.00	1.44	4.44	45.55	-0.32	-1.40	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1309	650.52	1.967	-0.705	4961.6	500.00	1.44	4.44	45.51	-0.37	-1.39	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1310	651.01	1.969	-0.705	4961.6	500.00	1.44	4.44	45.48	-0.45	-1.36	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1311	651.51	1.971	-0.706	4961.6	500.00	1.44	4.44	45.45	-0.53	-1.34	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1312	652.01	1.973	-0.706	4961.6	500.00	1.44	4.44	45.43	-0.60	-1.31	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1313	652.50	1.975	-0.706	4961.6	500.00	1.44	4.44	45.41	-0.67	-1.29	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1314	653.00	1.977	-0.706	4961.6	500.00	1.44	4.44	45.41	-0.73	-1.25	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1315	653.50	1.979	-0.706	4961.6	500.00	1.44	4.44	45.41	-0.79	-1.21	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1316	653.99	1.981	-0.706	4961.6	500.00	1.44	4.44	45.41	-0.85	-1.17	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1317	654.49	1.984	-0.707	4961.5	500.00	1.44	4.44	45.42	-0.91	-1.12	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1318	654.98	1.986	-0.707	4961.5	500.00	1.44	4.44	45.43	-0.95	-1.08	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1319	655.46	1.988	-0.707	4961.5	500.00	1.44	4.44	45.44	-1.01	-1.03	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1320	655.98	1.990	-0.707	4961.5	500.00	1.44	4.44	45.45	-1.06	-0.97	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1321	656.47	1.992	-0.707	4961.5	500.00	1.44	4.44	45.45	-1.11	-0.92	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1322	656.97	1.994	-0.707	4961.5	500.00	1.44	4.44	45.46	-1.15	-0.85	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1323	657.46	1.995	-0.706	4961.5	500.00	1.44	4.44	45.46	-1.19	-0.80	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1324	657.96	1.997	-0.706	4961.5	500.00	1.44	4.44	45.45	-1.23	-0.75	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1325	658.46	1.999	-0.706	4961.5	500.00	1.43	4.44	45.45	-1.27	-0.68	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1326	658.95	2.001	-0.706	4961.5	500.00	1.43	4.44	45.44	-1.30	-0.61	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1327	659.45	2.003	-0.705	4961.4	500.00	1.43	4.44	45.43	-1.33	-0.55	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1328	659.94	2.005	-0.706	4961.4	500.00	1.43	4.44	45.43	-1.35	-0.48	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1329	660.44	2.006	-0.706	4961.4	500.00	1.43	4.44	45.42	-1.37	-0.41	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1330	660.94	2.008	-0.705	4961.4	500.00	1.43	4.44	45.42	-1.39	-0.34	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1331	661.43	2.010	-0.705	4961.4	500.00	1.43	4.44	45.42	-1.41	-0.27	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1332	661.93	2.011	-0.705	4961.4	500.00	1.43	4.44	45.42	-1.42	-0.20	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1333	662.42	2.013	-0.705	4961.4	500.00	1.43	4.44	45.44	-1.43	-0.13	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1334	662.92	2.014	-0.705	4961.4	500.00	1.44	4.44	45.46	-1.43	-0.05	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1335	663.42	2.016	-0.704	4961.4	500.00	1.44	4.44	45.47	-1.44	0.01	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1336	663.91	2.017	-0.704	4961.3	500.00	1.44	4.44	45.51	-1.44	0.08	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1337	664.41	2.019	-0.704	4961.3	500.00	1.44	4.44	45.54	-1.43	0.15	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1338	664.91	2.020	-0.704	4961.3	500.00	1.44	4.44	45.55	-1.42	0.22	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1339	665.40	2.021	-0.704	4961.3	500.00	1.44	4.44	45.59	-1.41	0.29	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1340	665.90	2.023	-0.703	4961.3	500.00	1.44	4.44	45.62	-1.39	0.36	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1341	666.39	2.024	-0.703	4961.3	500.00	1.44	4.44	45.64	-1.37	0.43	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1342	666.89	2.025	-0.703	4961.3	500.00	1.44	4.44	45.65	-1.35	0.50	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1343	667.39	2.027	-0.703	4961.3	500.00	1.44	4.44	45.65	-1.32	0.57	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1344	667.88	2.028	-0.703	4961.3	500.00	1.44	4.44	45.65	-1.29	0.63	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1345	668.38	2.029	-0.703	4961.2	500.00	1.44	4.44	45.63	-1.25	0.70	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1346	668.87	2.030	-0.703	4961.2	500.00	1.44	4.44	45.61	-1.22	0.76	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1347	669.37	2.031	-0.703	4961.2	500.00	1.44	4.44	45.58	-1.18	0.82	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1348	669.87	2.032	-0.702	4961.2	500.00	1.44	4.44	45.54	-1.14	0.88	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1349	670.36	2.033	-0.702	4961.2	500.00	1.44	4.44	45.50	-1.09	0.94	-55.	-57.	2335.	-2332.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA (bar) DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-F RAD/SEC	S	TAU	K-T DEG
0.1350	670.85	2.034	-0.702	4961.2	500.00	1.44	4.44	45.46	-1.04	0.99	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1351	671.35	2.035	-0.702	4961.2	500.00	1.44	4.44	45.42	-0.99	1.04	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1352	671.85	2.036	-0.702	4961.2	500.00	1.44	4.44	45.39	-0.94	1.09	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1353	672.35	2.037	-0.702	4961.1	500.00	1.44	4.44	45.35	-0.86	1.14	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1354	672.84	2.038	-0.703	4961.1	500.00	1.44	4.44	45.32	-0.82	1.18	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1355	673.34	2.039	-0.703	4961.1	500.00	1.44	4.44	45.31	-0.75	1.22	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1356	673.83	2.040	-0.703	4961.1	500.00	1.44	4.44	45.30	-0.70	1.26	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1357	674.33	2.041	-0.703	4961.1	500.00	1.44	4.44	45.31	-0.64	1.29	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1358	674.83	2.041	-0.703	4961.1	500.00	1.44	4.44	45.32	-0.57	1.32	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1359	675.32	2.042	-0.703	4961.1	500.00	1.44	4.44	45.34	-0.51	1.35	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1360	675.82	2.043	-0.704	4961.1	500.00	1.44	4.44	45.37	-0.44	1.37	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1361	676.32	2.044	-0.704	4961.1	500.00	1.44	4.44	45.41	-0.37	1.39	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1362	676.81	2.045	-0.704	4961.0	500.00	1.44	4.44	45.44	-0.30	1.41	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1363	677.31	2.045	-0.705	4961.0	500.00	1.44	4.44	45.48	-0.23	1.42	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1364	677.80	2.046	-0.705	4961.0	500.00	1.44	4.44	45.51	-0.16	1.43	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1365	678.30	2.047	-0.706	4961.0	500.00	1.44	4.44	45.55	-0.09	1.43	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1366	678.79	2.048	-0.706	4961.0	500.00	1.44	4.44	45.57	-0.02	1.43	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1367	679.29	2.049	-0.707	4961.0	500.00	1.44	4.44	45.59	0.05	1.43	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1368	679.79	2.049	-0.707	4961.0	500.00	1.43	4.44	45.61	0.12	1.43	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1369	680.28	2.050	-0.708	4961.0	500.00	1.43	4.44	45.61	0.19	1.42	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1370	680.78	2.051	-0.708	4960.9	500.00	1.43	4.44	45.61	0.26	1.41	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1371	681.28	2.052	-0.709	4960.9	500.00	1.43	4.44	45.61	0.34	1.39	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1372	681.77	2.052	-0.710	4960.9	500.00	1.43	4.44	45.59	0.40	1.38	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1373	682.27	2.053	-0.711	4960.9	500.00	1.44	4.44	45.57	0.47	1.35	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1374	682.76	2.054	-0.711	4960.9	500.00	1.44	4.44	45.55	0.54	1.33	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1375	683.26	2.055	-0.712	4960.9	500.00	1.44	4.44	45.53	0.61	1.30	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1376	683.75	2.055	-0.713	4960.9	500.00	1.44	4.44	45.51	0.67	1.27	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1377	684.25	2.056	-0.714	4960.9	500.00	1.44	4.44	45.50	0.74	1.24	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1378	684.75	2.057	-0.715	4960.9	500.00	1.44	4.44	45.49	0.80	1.20	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1379	685.24	2.058	-0.716	4960.8	500.00	1.44	4.44	45.47	0.86	1.16	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1380	685.74	2.059	-0.717	4960.8	500.00	1.44	4.44	45.47	0.91	1.11	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1381	686.23	2.060	-0.718	4960.8	500.00	1.44	4.44	45.46	0.97	1.07	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1382	686.73	2.061	-0.719	4960.8	500.00	1.44	4.44	45.45	1.02	1.02	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1383	687.23	2.062	-0.720	4960.8	500.00	1.44	4.44	45.45	1.07	0.96	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1384	687.72	2.063	-0.721	4960.8	500.00	1.44	4.44	45.47	1.12	0.91	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1385	688.22	2.064	-0.722	4960.8	500.00	1.44	4.44	45.47	1.16	0.85	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1386	688.71	2.065	-0.723	4960.8	500.00	1.44	4.44	45.48	1.20	0.79	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1387	689.21	2.066	-0.724	4960.8	500.00	1.44	4.44	45.48	1.24	0.73	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1388	689.71	2.067	-0.725	4960.7	500.00	1.44	4.44	45.48	1.27	0.67	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1389	690.20	2.069	-0.726	4960.7	500.00	1.44	4.44	45.47	1.31	0.60	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1390	690.70	2.070	-0.728	4960.7	500.00	1.44	4.44	45.47	1.33	0.54	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1391	691.19	2.071	-0.729	4960.7	500.00	1.44	4.44	45.46	1.36	0.47	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1392	691.69	2.072	-0.730	4960.7	500.00	1.44	4.44	45.45	1.38	0.40	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1393	692.18	2.074	-0.731	4960.7	500.00	1.44	4.44	45.44	1.40	0.33	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1394	692.68	2.075	-0.733	4960.7	500.00	1.43	4.44	45.43	1.41	0.26	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1395	693.18	2.076	-0.734	4960.7	500.00	1.43	4.44	45.42	1.42	0.19	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1396	693.67	2.078	-0.735	4960.7	500.00	1.43	4.44	45.41	1.43	0.12	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1397	694.17	2.079	-0.736	4960.7	500.00	1.43	4.44	45.41	1.43	0.05	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1398	694.66	2.081	-0.737	4960.6	500.00	1.43	4.44	45.41	1.43	-0.03	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1399	695.16	2.082	-0.739	4960.6	500.00	1.43	4.44	45.42	1.43	-0.10	-55.	-57.	2335.	-2332.	-0.	0.	1.

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T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA~ DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-F RAD/SEC	S	TAU	K-T IFG
0.1400	695.66	2.084	-0.740	4960.6	500.00	1.44	4.44	45.43	1.43	-0.17	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1401	696.15	2.085	-0.741	4960.6	500.00	1.44	4.44	45.45	1.42	-0.24	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1402	696.65	2.087	-0.742	4960.6	500.00	1.44	4.44	45.47	1.40	-0.31	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1403	697.14	2.089	-0.744	4960.6	500.00	1.44	4.44	45.49	1.39	-0.38	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1404	697.64	2.090	-0.745	4960.5	500.00	1.44	4.44	45.51	1.37	-0.45	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1405	698.13	2.092	-0.746	4961.6	500.00	1.44	4.44	45.54	1.35	-0.52	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1406	698.63	2.094	-0.747	4960.6	500.00	1.44	4.44	45.55	1.32	-0.58	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1407	699.13	2.095	-0.749	4960.5	500.00	1.44	4.44	45.56	1.29	-0.65	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1408	699.62	2.097	-0.750	4960.5	500.00	1.44	4.44	45.60	1.25	-0.71	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1409	700.12	2.099	-0.751	4960.5	500.00	1.44	4.44	45.61	1.21	-0.77	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1410	700.61	2.101	-0.752	4960.5	500.00	1.44	4.44	45.61	1.17	-0.83	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1411	701.11	2.103	-0.753	4960.5	500.00	1.44	4.44	45.61	1.13	-0.89	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1412	701.61	2.105	-0.754	4960.5	500.00	1.44	4.44	45.60	1.09	-0.94	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1413	702.10	2.107	-0.755	4960.5	500.00	1.44	4.44	45.59	1.04	-1.00	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1414	702.60	2.109	-0.756	4960.5	500.00	1.44	4.44	45.56	0.98	-1.05	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1415	703.09	2.111	-0.757	4960.5	500.00	1.44	4.44	45.54	0.93	-1.10	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1416	703.59	2.113	-0.759	4960.4	500.00	1.44	4.44	45.51	0.87	-1.14	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1417	704.08	2.115	-0.759	4960.4	500.00	1.44	4.44	45.49	0.82	-1.19	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1418	704.58	2.117	-0.760	4960.4	500.00	1.44	4.44	45.45	0.75	-1.22	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1419	705.08	2.119	-0.761	4960.4	500.00	1.44	4.44	45.42	0.69	-1.25	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1420	705.57	2.121	-0.762	4960.4	500.00	1.44	4.44	45.40	0.63	-1.29	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1421	706.07	2.124	-0.763	4960.4	500.00	1.44	4.44	45.38	0.56	-1.32	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1422	706.56	2.126	-0.763	4960.4	500.00	1.44	4.44	45.37	0.49	-1.35	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1423	707.06	2.128	-0.764	4960.4	500.00	1.44	4.44	45.37	0.43	-1.37	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1424	707.56	2.130	-0.765	4960.4	500.00	1.44	4.44	45.37	0.36	-1.39	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1425	708.05	2.132	-0.766	4960.3	500.00	1.44	4.44	45.37	0.29	-1.41	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1426	708.55	2.135	-0.766	4960.3	500.00	1.44	4.44	45.39	0.22	-1.42	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1427	709.04	2.137	-0.767	4960.3	500.00	1.44	4.44	45.40	0.15	-1.43	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1428	709.54	2.139	-0.767	4960.3	500.00	1.44	4.44	45.43	0.07	-1.44	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1429	710.04	2.141	-0.768	4960.3	500.00	1.44	4.44	45.45	-0.00	-1.44	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1430	710.53	2.143	-0.768	4960.3	500.00	1.44	4.44	45.47	-0.07	-1.44	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1431	711.03	2.146	-0.769	4960.3	500.00	1.44	4.44	45.49	-0.14	-1.43	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1432	711.52	2.148	-0.769	4960.2	500.00	1.44	4.44	45.51	-0.21	-1.42	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1433	712.02	2.150	-0.770	4960.2	500.00	1.44	4.44	45.53	-0.28	-1.41	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1434	712.51	2.152	-0.770	4960.2	500.00	1.44	4.44	45.54	-0.35	-1.39	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1435	713.01	2.154	-0.770	4960.2	500.00	1.43	4.44	45.55	-0.42	-1.37	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1436	713.51	2.157	-0.771	4960.2	500.00	1.43	4.44	45.55	-0.49	-1.35	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1437	714.00	2.159	-0.771	4960.2	500.00	1.43	4.44	45.55	-0.55	-1.32	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1438	714.50	2.161	-0.771	4960.2	500.00	1.43	4.44	45.55	-0.62	-1.29	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1439	714.99	2.163	-0.771	4960.2	500.00	1.43	4.44	45.55	-0.68	-1.26	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1440	715.49	2.165	-0.772	4960.2	500.00	1.44	4.44	45.53	-0.75	-1.23	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1441	715.99	2.167	-0.772	4960.1	500.00	1.44	4.44	45.52	-0.81	-1.19	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1442	716.48	2.169	-0.772	4960.1	500.00	1.44	4.44	45.51	-0.87	-1.15	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1443	716.98	2.171	-0.772	4960.1	500.00	1.44	4.44	45.51	-0.92	-1.10	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1444	717.47	2.173	-0.772	4960.1	500.00	1.44	4.44	45.50	-0.98	-1.05	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1445	717.97	2.175	-0.772	4960.1	500.00	1.44	4.44	45.49	-1.03	-1.00	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1446	718.46	2.177	-0.772	4960.1	500.00	1.44	4.44	45.49	-1.08	-0.95	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1447	718.96	2.179	-0.772	4960.1	500.00	1.44	4.44	45.49	-1.12	-0.90	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1448	719.45	2.181	-0.772	4960.1	500.00	1.44	4.44	45.49	-1.17	-0.84	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1449	719.95	2.183	-0.772	4960.1	500.00	1.44	4.44	45.47	-1.21	-0.78	-55.	-57.	2335.	-2332.	-0.	0.	1.

FLECHETTE GROUND POINT

T	X	Y	Z	V		ALPHA	MACH	PHI	ALPHA	BETA	L-N	L-P	W-N	W-P	S	TAU	K-T
SEC	FT	FT	FT	FT/SEC	RAD/SEC	DEG		DEG	DEG	DEG	1/SEC	1/SEC	RAD/SEC	RAD/SEC			
0.1450	720.45	2.185	-0.772	4960.0	500.00	1.44	4.44	45.49	-1.25	-0.72	-55.	-57.	2337.	-2332.	-0.	0.	1.
0.1451	720.94	2.187	-0.771	4960.0	500.00	1.44	4.44	45.50	-1.28	-0.66	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1452	721.44	2.189	-0.771	4960.0	500.00	1.44	4.44	45.50	-1.31	-0.59	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1453	721.94	2.190	-0.771	4960.0	500.00	1.44	4.44	45.50	-1.33	-0.53	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1454	722.43	2.192	-0.771	4960.0	500.00	1.44	4.44	45.49	-1.35	-0.45	-55.	-57.	2337.	-2332.	-0.	0.	1.
0.1455	722.93	2.194	-0.771	4960.0	500.00	1.44	4.44	45.49	-1.38	-0.39	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1456	723.42	2.195	-0.771	4960.0	500.00	1.44	4.44	45.48	-1.40	-0.32	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1457	723.92	2.197	-0.770	4960.0	500.00	1.44	4.44	45.48	-1.42	-0.25	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1458	724.41	2.199	-0.770	4960.0	500.00	1.44	4.44	45.47	-1.43	-0.18	-55.	-57.	2337.	-2332.	-0.	0.	1.
0.1459	724.91	2.200	-0.770	4959.9	500.00	1.44	4.44	45.46	-1.43	-0.10	-55.	-57.	2336.	-2332.	-0.	0.	1.
0.1460	725.41	2.202	-0.770	4959.9	500.00	1.44	4.44	45.44	-1.44	-0.03	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1461	725.90	2.203	-0.770	4959.9	500.00	1.44	4.44	45.43	-1.43	0.04	-55.	-57.	2333.	-2332.	-0.	0.	1.
0.1462	726.40	2.205	-0.769	4959.9	500.00	1.44	4.44	45.43	-1.43	0.11	-55.	-57.	2333.	-2332.	-0.	0.	1.
0.1463	726.89	2.206	-0.769	4959.9	500.00	1.43	4.44	45.42	-1.42	0.18	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1464	727.39	2.208	-0.769	4959.9	500.00	1.43	4.44	45.42	-1.41	0.25	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1465	727.89	2.209	-0.769	4959.9	500.00	1.44	4.44	45.42	-1.40	0.32	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1466	728.38	2.210	-0.769	4959.9	500.00	1.44	4.44	45.42	-1.38	0.39	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1467	728.88	2.212	-0.769	4959.9	500.00	1.44	4.44	45.43	-1.35	0.46	-55.	-57.	2337.	-2332.	-0.	0.	1.
0.1468	729.37	2.213	-0.769	4959.9	500.00	1.44	4.44	45.45	-1.33	0.53	-55.	-57.	2331.	-2332.	-0.	0.	1.
0.1469	729.87	2.214	-0.768	4959.8	500.00	1.44	4.44	45.46	-1.31	0.60	-55.	-57.	2331.	-2332.	-0.	0.	1.
0.1470	730.36	2.215	-0.768	4959.8	500.00	1.44	4.44	45.48	-1.28	0.66	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1471	730.86	2.216	-0.768	4959.8	500.00	1.44	4.44	45.50	-1.24	0.72	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1472	731.36	2.217	-0.768	4959.8	500.00	1.44	4.44	45.52	-1.20	0.78	-55.	-57.	2337.	-2332.	-0.	0.	1.
0.1473	731.85	2.219	-0.768	4959.8	500.00	1.44	4.44	45.54	-1.15	0.84	-55.	-57.	2331.	-2332.	-0.	0.	1.
0.1474	732.35	2.220	-0.768	4959.8	500.00	1.44	4.44	45.55	-1.12	0.90	-55.	-57.	2337.	-2332.	-0.	0.	1.
0.1475	732.84	2.221	-0.768	4959.8	500.00	1.44	4.44	45.57	-1.08	0.95	-55.	-57.	2335.	-2332.	-0.	0.	1.
0.1476	733.34	2.222	-0.768	4959.8	500.00	1.44	4.44	45.57	-1.03	1.01	-55.	-57.	2337.	-2333.	-0.	0.	1.
0.1477	733.84	2.223	-0.768	4959.7	500.00	1.44	4.44	45.58	-0.97	1.06	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1478	734.33	2.224	-0.768	4959.7	500.00	1.44	4.4	45.59	-0.92	1.10	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1479	734.83	2.224	-0.769	4959.7	500.00	1.44	4.44	45.57	-0.85	1.15	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1480	735.32	2.225	-0.769	4959.7	500.00	1.44	4.44	45.56	-0.81	1.19	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1481	735.82	2.226	-0.768	4959.7	500.00	1.44	4.44	45.55	-0.77	1.23	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1482	736.32	2.227	-0.768	4959.7	500.00	1.44	4.44	45.53	-0.69	1.26	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1483	736.81	2.229	-0.768	4959.7	500.00	1.44	4.44	45.51	-0.62	1.30	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1484	737.31	2.229	-0.769	4959.7	500.00	1.44	4.44	45.49	-0.55	1.33	-55.	-57.	2334.	-2333.	-0.	0.	1.
0.1485	737.80	2.230	-0.769	4959.6	500.00	1.44	4.44	45.47	-0.48	1.35	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1486	738.30	2.231	-0.769	4959.6	500.00	1.44	4.44	45.45	-0.42	1.38	-55.	-57.	2334.	-2333.	-0.	0.	1.
0.1487	738.79	2.231	-0.769	4959.6	500.00	1.44	4.44	45.44	-0.35	1.40	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1488	739.29	2.232	-0.771	4959.6	500.00	1.44	4.44	45.42	-0.27	1.41	-55.	-57.	2336.	-2334.	-0.	0.	1.
0.1489	739.79	2.233	-0.771	4959.6	500.00	1.44	4.44	45.42	-0.20	1.42	-55.	-57.	2337.	-2333.	-0.	0.	1.
0.1490	740.28	2.233	-0.771	4959.6	500.00	1.44	4.44	45.41	-0.13	1.43	-55.	-57.	2334.	-2333.	-0.	0.	1.
0.1491	740.78	2.234	-0.771	4959.6	500.00	1.44	4.44	45.41	-0.05	1.44	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1492	741.27	2.235	-0.772	4959.6	500.00	1.44	4.44	45.41	0.01	1.44	-55.	-57.	2337.	-2333.	-0.	0.	1.
0.1493	741.77	2.236	-0.772	4959.6	500.00	1.44	4.44	45.42	0.08	1.44	-55.	-57.	2334.	-2333.	-0.	0.	1.
0.1494	742.27	2.237	-0.773	4959.5	500.00	1.44	4.44	45.43	0.15	1.43	-55.	-57.	2334.	-2333.	-0.	0.	1.
0.1495	742.76	2.237	-0.773	4959.5	500.00	1.44	4.44	45.44	0.22	1.42	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1496	743.26	2.238	-0.774	4959.5	500.00	1.44	4.44	45.46	0.30	1.41	-55.	-57.	2336.	-2334.	-0.	0.	1.
0.1497	743.75	2.239	-0.775	4959.5	500.00	1.44	4.44	45.47	0.36	1.39	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1498	744.25	2.240	-0.775	4959.5	500.00	1.44	4.44	45.45	0.43	1.37	-55.	-57.	2337.	-2333.	-0.	0.	1.
0.1499	744.74	2.240	-0.776	4959.5	500.00	1.44	4.44	45.49	0.50	1.35	-55.	-57.	2336.	-2333.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	$\tilde{\text{ALPHA}}$ DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-V 1/SEC	L-P 1/SEC	H-V RAD/SEC	H-P RAD/SEC	S	TAU	K-T DEG
0.1500	745.24	2.241	-0.777	4959.5	500.00	1.44	4.44	45.50	0.67	1.32	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1501	745.74	2.242	-0.778	4959.5	500.00	1.44	4.44	45.51	0.63	1.29	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1502	746.23	2.243	-0.779	4959.5	500.00	1.43	4.44	45.51	0.70	1.25	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1503	746.73	2.244	-0.779	4959.4	500.00	1.43	4.44	45.52	0.76	1.22	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1504	747.22	2.245	-0.780	4959.4	500.00	1.43	4.44	45.52	0.82	1.18	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1505	747.72	2.245	-0.781	4959.4	500.00	1.43	4.44	45.51	0.88	1.14	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1506	748.22	2.246	-0.782	4959.4	500.00	1.43	4.44	45.51	0.93	1.09	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1507	748.71	2.247	-0.783	4959.4	500.00	1.43	4.44	45.51	0.99	1.05	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1508	749.21	2.248	-0.784	4959.4	500.00	1.44	4.44	45.50	1.04	0.99	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1509	749.70	2.249	-0.785	4959.4	500.00	1.44	4.44	45.50	1.09	0.94	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1510	750.20	2.250	-0.785	4959.4	500.00	1.44	4.44	45.50	1.13	0.89	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1511	750.69	2.251	-0.788	4959.3	500.00	1.44	4.44	45.50	1.17	0.83	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1512	751.19	2.253	-0.789	4959.3	500.00	1.44	4.44	45.50	1.21	0.77	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1513	751.69	2.254	-0.790	4959.3	500.00	1.44	4.44	45.50	1.25	0.71	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1514	752.18	2.255	-0.791	4959.3	500.00	1.44	4.44	45.50	1.29	0.66	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1515	752.68	2.256	-0.792	4959.3	500.00	1.44	4.44	45.51	1.32	0.59	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1516	753.17	2.257	-0.793	4959.3	500.00	1.44	4.44	45.50	1.34	0.51	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1517	753.67	2.258	-0.795	4959.3	500.00	1.44	4.44	45.51	1.37	0.44	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1518	754.17	2.260	-0.796	4959.3	500.00	1.44	4.44	45.51	1.39	0.38	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1519	754.65	2.261	-0.797	4959.2	500.00	1.44	4.44	45.51	1.41	0.31	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1520	755.16	2.262	-0.798	4959.2	500.00	1.44	4.44	45.51	1.42	0.24	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1521	755.65	2.264	-0.799	4959.2	500.00	1.44	4.44	45.50	1.43	0.15	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1522	756.15	2.265	-0.801	4959.2	500.00	1.44	4.44	45.50	1.43	0.09	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1523	756.65	2.267	-0.802	4959.2	500.00	1.44	4.44	45.49	1.44	-0.02	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1524	757.14	2.268	-0.803	4959.2	500.00	1.44	4.44	45.48	1.44	-0.07	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1525	757.64	2.270	-0.804	4959.2	500.00	1.44	4.44	45.47	1.43	-0.12	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1526	758.13	2.271	-0.806	4959.2	500.00	1.44	4.44	45.45	1.42	-0.20	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1527	758.63	2.273	-0.807	4959.2	500.00	1.44	4.44	45.45	1.41	-0.27	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1528	759.12	2.275	-0.808	4959.1	500.00	1.44	4.44	45.45	1.40	-0.34	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1529	759.62	2.276	-0.809	4959.1	500.00	1.44	4.44	45.44	1.39	-0.41	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1530	760.12	2.278	-0.811	4959.1	500.00	1.44	4.44	45.43	1.37	-0.47	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1531	760.61	2.280	-0.812	4959.1	500.00	1.44	4.44	45.43	1.33	-0.54	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1532	761.11	2.281	-0.813	4959.1	500.00	1.44	4.44	45.43	1.33	-0.61	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1533	761.60	2.283	-0.814	4959.1	500.00	1.44	4.44	45.43	1.27	-0.67	-55.	-57.	2334.	-2333.	-0.	0.	1.
0.1534	762.10	2.285	-0.815	4959.1	500.00	1.44	4.44	45.44	1.23	-0.73	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1535	762.60	2.287	-0.816	4959.1	500.00	1.44	4.44	45.45	1.23	-0.80	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1536	763.09	2.289	-0.818	4959.0	500.00	1.44	4.44	45.46	1.15	-0.85	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1537	763.59	2.291	-0.819	4959.0	500.00	1.44	4.44	45.47	1.11	-0.91	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1538	764.08	2.293	-0.820	4959.0	500.00	1.44	4.44	45.49	1.05	-0.95	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1539	764.58	2.295	-0.821	4959.0	500.00	1.44	4.44	45.51	1.11	-1.02	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1540	765.07	2.297	-0.822	4959.0	500.00	1.44	4.44	45.52	0.95	-1.07	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1541	765.57	2.299	-0.823	4959.0	500.00	1.44	4.44	45.53	0.91	-1.11	-55.	-57.	2334.	-2333.	-0.	0.	1.
0.1542	766.07	2.301	-0.824	4959.0	500.00	1.44	4.44	45.54	0.85	-1.15	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1543	766.56	2.303	-0.825	4959.0	500.00	1.44	4.44	45.55	0.79	-1.20	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1544	767.05	2.305	-0.826	4959.0	500.00	1.44	4.44	45.55	0.73	-1.24	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1545	767.55	2.307	-0.826	4958.9	500.00	1.44	4.44	45.55	0.67	-1.27	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1546	768.05	2.309	-0.827	4958.9	500.00	1.44	4.44	45.55	0.61	-1.30	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1547	768.55	2.311	-0.828	4958.9	500.00	1.44	4.44	45.54	0.54	-1.33	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1548	769.04	2.314	-0.829	4958.9	500.00	1.44	4.44	45.53	0.47	-1.36	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1549	769.54	2.316	-0.830	4958.9	500.00	1.44	4.44	45.52	0.40	-1.38	-55.	-57.	2335.	-2333.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-A 1/SEC	L-P 1/SEC	W-G FAD/SEC	W-P RAD/SEC	S	TAU	Y-T DEG
0.1550	770.03	2.319	-0.839	4958.9	500.00	1.44	4.44	45.51	0.33	-1.40	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1551	770.53	2.320	-0.831	4958.9	500.00	1.44	4.44	45.50	0.25	-1.41	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1552	771.02	2.322	-0.832	4958.9	500.00	1.44	4.44	45.49	0.13	-1.42	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1553	771.52	2.325	-0.832	4958.9	500.00	1.44	4.44	45.47	0.12	-1.43	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1554	772.02	2.327	-0.833	4958.8	500.00	1.44	4.44	45.46	0.05	-1.44	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1555	772.51	2.329	-0.833	4958.8	500.00	1.44	4.44	45.45	-0.02	-1.44	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1556	773.01	2.331	-0.834	4958.8	500.00	1.44	4.44	45.45	-0.10	-1.43	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1557	773.50	2.333	-0.834	4958.8	500.00	1.44	4.44	45.44	-0.17	-1.43	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1558	774.00	2.336	-0.835	4958.8	500.00	1.44	4.44	45.44	-0.24	-1.42	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1559	774.50	2.338	-0.835	4958.8	500.00	1.44	4.44	45.45	-0.31	-1.40	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1560	774.99	2.340	-0.835	4958.8	500.00	1.44	4.44	45.45	-0.38	-1.39	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1561	775.49	2.342	-0.836	4958.8	500.00	1.44	4.44	45.45	-0.44	-1.37	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1562	775.99	2.344	-0.836	4958.7	500.00	1.44	4.44	45.46	-0.51	-1.34	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1563	776.48	2.347	-0.836	4958.7	500.00	1.44	4.44	45.37	-0.58	-1.31	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1564	776.97	2.349	-0.837	4958.7	500.00	1.44	4.44	45.47	-0.65	-1.26	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1565	777.47	2.351	-0.837	4958.7	500.00	1.44	4.44	45.48	-0.71	-1.25	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1566	777.97	2.353	-0.837	4958.7	500.00	1.44	4.44	45.49	-0.77	-1.21	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1567	778.46	2.355	-0.837	4958.7	500.00	1.44	4.44	45.49	-0.83	-1.17	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1568	778.96	2.357	-0.837	4958.7	500.00	1.44	4.44	45.49	-0.89	-1.13	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1569	779.45	2.359	-0.837	4958.7	500.00	1.43	4.44	45.50	-0.95	-1.03	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1570	779.95	2.361	-0.837	4958.6	500.00	1.43	4.44	45.50	-0.99	-1.03	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1571	780.45	2.363	-0.837	4958.6	500.00	1.43	4.44	45.50	-1.05	-0.98	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1572	780.94	2.365	-0.837	4958.6	500.00	1.43	4.44	45.49	-1.09	-0.93	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1573	781.44	2.367	-0.837	4958.6	500.00	1.43	4.44	45.49	-1.15	-0.87	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1574	781.93	2.369	-0.837	4958.6	500.00	1.43	4.44	45.49	-1.13	-0.82	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1575	782.43	2.371	-0.837	4958.6	500.00	1.43	4.44	45.49	-1.22	-0.75	-55.	-57.	2334.	-2333.	-0.	0.	1.
0.1576	782.93	2.373	-0.837	4958.6	500.00	1.44	4.44	45.49	-1.25	-0.69	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1577	783.42	2.375	-0.837	4958.6	500.00	1.44	4.44	45.49	-1.27	-0.63	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1578	783.92	2.376	-0.837	4958.4	500.00	1.44	4.44	45.49	-1.32	-0.57	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1579	784.41	2.378	-0.836	4958.5	500.00	1.44	4.44	45.49	-1.35	-0.50	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1580	784.91	2.380	-0.836	4958.5	500.00	1.44	4.44	45.50	-1.37	-0.43	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1581	785.40	2.382	-0.836	4958.5	500.00	1.44	4.44	45.50	-1.31	-0.35	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1582	785.90	2.383	-0.836	4958.5	500.00	1.44	4.44	45.50	-1.41	-0.29	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1583	786.40	2.385	-0.836	4958.5	500.00	1.44	4.44	45.51	-1.42	-0.22	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1584	786.89	2.386	-0.835	4958.5	500.00	1.44	4.44	45.51	-1.43	-0.15	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1585	787.39	2.388	-0.835	4958.5	500.00	1.44	4.44	45.51	-1.43	-0.08	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1586	787.88	2.390	-0.835	4958.5	500.00	1.44	4.44	45.51	-1.43	-0.01	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1587	788.38	2.391	-0.835	4958.5	500.00	1.44	4.44	45.51	-1.43	0.06	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1588	788.87	2.392	-0.835	4958.4	500.00	1.44	4.44	45.51	-1.43	0.14	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1589	789.37	2.394	-0.834	4958.4	500.00	1.44	4.44	45.50	-1.42	0.21	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1590	789.86	2.395	-0.834	4958.4	500.00	1.44	4.44	45.50	-1.41	0.28	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1591	790.36	2.396	-0.834	4958.4	500.00	1.44	4.44	45.49	-1.33	0.35	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1592	790.86	2.398	-0.834	4958.4	500.00	1.44	4.44	45.48	-1.37	0.42	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1593	791.35	2.399	-0.834	4958.4	500.00	1.44	4.44	45.47	-1.35	0.49	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1594	791.85	2.400	-0.834	4958.4	500.00	1.44	4.44	45.46	-1.32	0.55	-55.	-57.	2335.	-2333.	-0.	0.	1.
0.1595	792.34	2.401	-0.833	4958.4	500.00	1.44	4.44	45.45	-1.27	0.62	-55.	-57.	2334.	-2333.	-0.	1.	1.
0.1596	792.84	2.403	-0.833	4958.3	500.00	1.44	4.44	45.45	-1.25	0.69	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1597	793.33	2.404	-0.833	4958.3	500.00	1.44	4.44	45.45	-1.21	0.75	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1598	793.83	2.405	-0.833	4958.3	500.00	1.44	4.44	45.44	-1.17	0.81	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1599	794.32	2.406	-0.833	4958.3	500.00	1.44	4.44	45.44	-1.15	0.86	-55.	-57.	2337.	-2333.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA (bar) DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-M 1/SEC	L-P 1/SEC	M-M RAD/SEC	N-P RAD/SEC	S	TAU	K-T DEG
0.1600	794.82	2.407	-0.833	4958.3	500.00	1.44	4.44	45.44	-1.13	0.92	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1601	795.32	2.408	-0.833	4958.3	500.00	1.44	4.44	45.45	-1.05	0.97	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1602	795.81	2.409	-0.833	4958.3	500.00	1.44	4.44	45.45	-1.00	1.03	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1603	796.31	2.410	-0.833	4958.3	500.00	1.44	4.44	45.46	-0.95	1.07	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1604	796.80	2.411	-0.833	4958.2	500.00	1.44	4.44	45.47	-0.90	1.12	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1605	797.30	2.412	-0.833	4958.2	500.00	1.44	4.44	45.49	-0.86	1.16	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1606	797.79	2.413	-0.833	4958.2	500.00	1.44	4.44	45.49	-0.73	1.20	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1607	798.29	2.414	-0.833	4958.2	500.00	1.44	4.44	45.50	-0.72	1.24	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1608	798.79	2.414	-0.834	4958.2	500.00	1.44	4.44	45.51	-0.65	1.29	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1609	799.28	2.415	-0.834	4958.2	500.00	1.44	4.44	45.52	-0.59	1.31	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1610	799.78	2.416	-0.834	4958.2	500.00	1.44	4.44	45.52	-0.53	1.34	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1611	800.27	2.417	-0.834	4958.2	500.00	1.44	4.44	45.53	-0.46	1.36	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1612	800.77	2.418	-0.835	4958.2	500.00	1.44	4.44	45.53	-0.39	1.38	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1613	801.26	2.418	-0.835	4958.1	500.00	1.44	4.44	45.53	-0.32	1.40	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1614	801.76	2.419	-0.835	4958.1	500.00	1.44	4.44	45.52	-0.25	1.41	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1615	802.25	2.420	-0.836	4958.1	500.00	1.44	4.44	45.52	-0.18	1.42	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1616	802.75	2.421	-0.836	4958.1	500.00	1.44	4.44	45.51	-0.11	1.43	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1617	803.25	2.422	-0.837	4958.1	500.00	1.44	4.44	45.50	-0.04	1.43	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1618	803.74	2.422	-0.837	4958.1	500.00	1.44	4.44	45.50	0.04	1.44	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1619	804.24	2.423	-0.838	4958.1	500.00	1.44	4.44	45.49	0.11	1.43	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1620	804.73	2.424	-0.838	4958.1	500.00	1.44	4.44	45.49	0.18	1.42	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1621	805.23	2.425	-0.839	4958.1	500.00	1.44	4.44	45.47	0.25	1.41	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1622	805.72	2.425	-0.840	4958.0	500.00	1.44	4.44	45.47	0.32	1.40	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1623	806.22	2.426	-0.840	4958.0	500.00	1.44	4.44	45.47	0.39	1.38	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1624	806.72	2.427	-0.841	4958.0	500.00	1.44	4.44	45.46	0.46	1.36	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1625	807.21	2.428	-0.842	4958.0	500.00	1.44	4.44	45.45	0.53	1.35	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1626	807.71	2.429	-0.843	4958.0	500.00	1.44	4.44	45.45	0.59	1.31	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1627	808.20	2.429	-0.843	4958.0	500.00	1.44	4.44	45.46	0.65	1.28	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1628	808.70	2.430	-0.844	4958.0	500.00	1.44	4.44	45.47	0.72	1.24	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1629	809.19	2.431	-0.845	4958.0	500.00	1.44	4.44	45.47	0.78	1.20	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1630	809.69	2.432	-0.846	4957.9	500.00	1.44	4.44	45.47	0.84	1.16	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1631	810.18	2.433	-0.847	4957.9	500.00	1.44	4.44	45.48	0.90	1.12	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1632	810.68	2.434	-0.848	4957.9	500.00	1.44	4.44	45.46	0.95	1.07	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1633	811.18	2.435	-0.849	4957.9	500.00	1.44	4.44	45.45	1.00	1.02	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1634	811.67	2.436	-0.850	4957.9	500.00	1.44	4.44	45.46	1.05	0.97	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1635	812.17	2.437	-0.851	4957.9	500.00	1.43	4.44	45.44	1.10	0.92	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1636	812.66	2.438	-0.852	4957.9	500.00	1.43	4.44	45.43	1.15	0.85	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1637	813.16	2.439	-0.853	4957.9	500.00	1.43	4.44	45.43	1.19	0.80	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1638	813.65	2.440	-0.854	4957.8	500.00	1.43	4.44	45.43	1.23	0.74	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1639	814.15	2.441	-0.856	4957.8	500.00	1.43	4.44	45.44	1.26	0.55	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1640	814.64	2.442	-0.857	4957.8	500.00	1.43	4.44	45.43	1.29	0.42	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1641	815.14	2.443	-0.858	4957.8	500.00	1.43	4.44	45.48	1.32	0.55	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1642	815.64	2.445	-0.859	4957.8	500.00	1.43	4.44	45.48	1.35	0.49	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1643	816.13	2.446	-0.860	4957.8	500.00	1.43	4.44	45.49	1.37	0.42	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1644	816.63	2.447	-0.862	4957.8	500.00	1.44	4.44	45.49	1.39	0.35	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1645	817.12	2.449	-0.863	4957.8	500.00	1.44	4.44	45.49	1.41	0.28	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1646	817.62	2.450	-0.864	4957.8	500.00	1.44	4.44	45.49	1.42	0.21	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1647	818.11	2.451	-0.865	4957.7	500.00	1.44	4.44	45.50	1.43	0.14	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1648	818.61	2.453	-0.866	4957.7	500.00	1.44	4.44	45.50	1.43	0.07	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1649	819.11	2.454	-0.868	4957.7	500.00	1.44	4.44	45.50	1.44	-0.01	-55.	-57.	2336.	-2333.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.1650	819.60	2.456	-0.869	4957.7	500.00	1.44	4.44	45.51	1.43	-0.05	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1651	820.10	2.457	-0.870	4957.7	500.00	1.44	4.44	45.51	1.43	-0.15	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1652	820.59	2.459	-0.871	4957.7	500.00	1.44	4.44	45.51	1.42	-0.22	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1653	821.09	2.460	-0.873	4957.7	500.00	1.44	4.44	45.51	1.41	-0.27	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1654	821.59	2.462	-0.874	4957.7	500.00	1.44	4.44	45.51	1.39	-0.35	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1655	822.09	2.464	-0.875	4957.7	500.00	1.44	4.44	45.51	1.37	-0.43	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1656	822.57	2.466	-0.876	4957.6	500.00	1.44	4.44	45.50	1.35	-0.50	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1657	823.07	2.467	-0.877	4957.6	500.00	1.44	4.44	45.50	1.32	-0.57	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1658	823.57	2.469	-0.879	4957.6	500.00	1.44	4.44	45.49	1.29	-0.63	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1659	824.06	2.471	-0.880	4957.6	500.00	1.44	4.44	45.48	1.26	-0.69	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1660	824.56	2.473	-0.881	4957.6	500.00	1.44	4.44	45.48	1.22	-0.75	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1661	825.05	2.475	-0.882	4957.6	500.00	1.44	4.44	45.47	1.18	-0.82	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1662	825.55	2.477	-0.883	4957.6	500.00	1.44	4.44	45.47	1.14	-0.87	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1663	826.04	2.478	-0.884	4957.6	500.00	1.44	4.44	45.46	1.09	-0.93	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1664	826.54	2.480	-0.885	4957.5	500.00	1.44	4.44	45.46	1.04	-0.98	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1665	827.03	2.482	-0.886	4957.5	500.00	1.44	4.44	45.45	0.97	-1.04	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1666	827.53	2.484	-0.887	4957.5	500.00	1.44	4.44	45.45	0.93	-1.08	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1667	828.03	2.487	-0.888	4957.5	500.00	1.44	4.44	45.45	0.89	-1.13	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1668	828.52	2.489	-0.889	4957.5	500.00	1.44	4.44	45.46	0.83	-1.17	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1669	829.02	2.491	-0.890	4957.5	500.00	1.44	4.44	45.46	0.77	-1.21	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1670	829.51	2.493	-0.891	4957.5	500.00	1.44	4.44	45.47	0.71	-1.25	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1671	830.01	2.495	-0.892	4957.5	500.00	1.44	4.44	45.47	0.64	-1.28	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1672	830.50	2.497	-0.893	4957.4	500.00	1.44	4.44	45.48	0.58	-1.31	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1673	831.00	2.499	-0.894	4957.4	500.00	1.44	4.44	45.49	0.51	-1.34	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1674	831.50	2.501	-0.894	4957.4	500.00	1.43	4.44	45.49	0.45	-1.36	-55.	-57.	2336.	-2333.	-0.	0.	1.
0.1675	831.99	2.504	-0.895	4957.4	500.00	1.43	4.44	45.50	0.38	-1.38	-55.	-57.	2336.	-2334.	-0.	0.	1.
0.1676	832.49	2.506	-0.896	4957.4	500.00	1.43	4.44	45.51	0.31	-1.40	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1677	832.98	2.508	-0.897	4957.4	500.00	1.43	4.44	45.51	0.24	-1.42	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1678	833.48	2.510	-0.897	4957.4	500.00	1.43	4.44	45.51	0.17	-1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1679	833.97	2.512	-0.898	4957.4	500.00	1.43	4.44	45.51	0.09	-1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1680	834.47	2.515	-0.898	4957.4	500.00	1.43	4.44	45.51	0.02	-1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1681	834.96	2.517	-0.899	4957.3	500.00	1.43	4.44	45.51	-0.05	-1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1682	835.46	2.519	-0.899	4957.3	500.00	1.43	4.44	45.51	-0.12	-1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1683	835.96	2.521	-0.900	4957.3	500.00	1.43	4.44	45.50	-0.19	-1.42	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1684	836.45	2.523	-0.900	4957.3	500.00	1.43	4.44	45.50	-0.26	-1.41	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1685	836.95	2.526	-0.900	4957.3	500.00	1.44	4.44	45.49	-0.33	-1.40	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1686	837.44	2.528	-0.901	4957.3	500.00	1.44	4.44	45.49	-0.40	-1.38	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1687	837.94	2.530	-0.901	4957.3	500.00	1.44	4.44	45.49	-0.47	-1.35	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1688	838.43	2.532	-0.901	4957.3	500.00	1.44	4.44	45.49	-0.54	-1.33	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1689	838.93	2.534	-0.902	4957.2	500.00	1.44	4.44	45.48	-0.60	-1.30	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1690	839.43	2.536	-0.902	4957.2	500.00	1.44	4.44	45.48	-0.67	-1.27	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1691	839.92	2.539	-0.902	4957.2	500.00	1.44	4.44	45.48	-0.73	-1.24	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1692	840.42	2.541	-0.902	4957.2	500.00	1.44	4.44	45.47	-0.79	-1.20	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1693	840.91	2.543	-0.902	4957.2	500.00	1.44	4.44	45.47	-0.85	-1.16	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1694	841.41	2.545	-0.902	4957.2	500.00	1.44	4.44	45.46	-0.91	-1.11	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1695	841.90	2.547	-0.902	4957.2	500.00	1.44	4.44	45.46	-0.95	-1.06	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1696	842.40	2.549	-0.902	4957.2	500.00	1.44	4.44	45.46	-1.01	-1.02	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1697	842.89	2.551	-0.902	4957.2	500.00	1.44	4.44	45.43	-1.05	-0.96	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1698	843.39	2.553	-0.902	4957.1	500.00	1.44	4.44	45.48	-1.11	-0.91	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1699	843.89	2.555	-0.907	4957.1	500.00	1.44	4.44	45.45	-1.15	-0.85	-55.	-57.	2337.	-2334.	-0.	0.	1.

FLECHETTE GROUND POINT

T	X	Y	Z	V	P	ALPHA	MACH	PHI	ALPHA	BETA	L-N	L-P	W-N	W-P	S	TAU	K-T
SEC	FT	FT	FT	FT/SEC	RAD/SEC	DEG		DEG	DEG	DEG	1/SEC	1/SEC	RAD/SEC	RAD/SEC			DEG
0.1700	844.35	2.557	-0.902	4957.1	500.00	1.43	4.44	45.48	-1.23	-0.79	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1701	844.86	2.559	-0.902	4957.1	500.00	1.43	4.44	45.49	-1.21	-0.73	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1702	845.37	2.560	-0.902	4957.1	500.00	1.43	4.44	45.49	-1.17	-0.57	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1703	845.87	2.562	-0.902	4957.1	500.00	1.43	4.44	45.48	-1.33	-0.51	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1704	846.36	2.564	-0.902	4957.1	500.00	1.43	4.44	45.45	-1.33	-0.54	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1705	846.86	2.565	-0.902	4957.1	500.00	1.43	4.44	45.49	-1.35	-0.47	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1706	847.35	2.567	-0.901	4957.1	500.00	1.43	4.44	45.48	-1.35	-0.40	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1707	847.85	2.569	-0.901	4957.0	500.00	1.43	4.44	45.45	-1.39	-0.33	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1708	848.35	2.571	-0.901	4957.0	500.00	1.43	4.44	45.48	-1.41	-0.25	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1709	848.84	2.572	-0.901	4957.0	500.00	1.43	4.44	45.49	-1.42	-0.19	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1710	849.34	2.574	-0.901	4957.0	500.00	1.43	4.44	45.48	-1.44	-0.12	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1711	849.83	2.575	-0.900	4957.0	500.00	1.43	4.44	45.48	-1.43	-0.05	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1712	850.33	2.577	-0.900	4957.0	500.00	1.43	4.44	45.49	-1.43	0.02	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1713	850.82	2.578	-0.900	4957.0	500.00	1.43	4.44	45.49	-1.44	0.09	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1714	851.32	2.580	-0.900	4957.0	500.00	1.43	4.44	45.49	-1.43	0.16	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1715	851.82	2.581	-0.900	4956.9	500.00	1.43	4.44	45.50	-1.42	0.23	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1716	852.31	2.583	-0.899	4956.9	500.00	1.44	4.44	45.50	-1.40	0.30	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1717	852.81	2.584	-0.899	4956.9	500.00	1.44	4.44	45.51	-1.37	0.37	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1718	853.30	2.585	-0.899	4956.9	500.00	1.44	4.44	45.50	-1.45	0.44	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1719	853.80	2.586	-0.899	4956.9	500.00	1.44	4.44	45.50	-1.35	0.51	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1720	854.29	2.588	-0.899	4956.9	500.00	1.44	4.44	45.51	-1.31	0.58	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1721	854.79	2.589	-0.899	4956.9	500.00	1.44	4.44	45.50	-1.23	0.64	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1722	855.28	2.590	-0.898	4956.9	500.00	1.44	4.44	45.50	-1.25	0.71	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1723	855.78	2.591	-0.898	4956.9	500.00	1.44	4.44	45.50	-1.21	0.77	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1724	856.28	2.592	-0.898	4956.8	500.00	1.43	4.44	45.50	-1.17	0.83	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1725	856.77	2.593	-0.898	4956.8	500.00	1.43	4.44	45.49	-1.13	0.88	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1726	857.27	2.594	-0.898	4956.8	500.00	1.43	4.44	45.49	-1.09	0.94	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1727	857.76	2.595	-0.897	4956.8	500.00	1.43	4.44	45.48	-1.04	0.99	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1728	858.26	2.596	-0.897	4956.8	500.00	1.43	4.44	45.48	-0.98	1.04	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1729	858.75	2.597	-0.897	4956.8	500.00	1.43	4.44	45.47	-0.93	1.09	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1730	859.25	2.598	-0.896	4956.8	500.00	1.43	4.44	45.47	-0.88	1.14	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1731	859.74	2.599	-0.896	4956.8	500.00	1.43	4.44	45.47	-0.82	1.18	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1732	860.24	2.600	-0.896	4956.7	500.00	1.43	4.44	45.46	-0.76	1.22	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1733	860.74	2.601	-0.895	4956.7	500.00	1.43	4.44	45.46	-0.70	1.26	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1734	861.23	2.602	-0.895	4956.7	500.00	1.43	4.44	45.46	-0.63	1.29	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1735	861.73	2.602	-0.895	4956.7	500.00	1.43	4.44	45.47	-0.57	1.32	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1736	862.22	2.603	-0.894	4956.7	500.00	1.43	4.44	45.47	-0.50	1.34	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1737	862.72	2.604	-0.894	4956.7	500.00	1.43	4.44	45.47	-0.43	1.37	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1738	863.21	2.605	-0.893	4956.7	500.00	1.43	4.44	45.48	-0.36	1.39	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1739	863.71	2.605	-0.893	4956.7	500.00	1.43	4.44	45.48	-0.29	1.40	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1740	864.21	2.606	-0.892	4956.7	500.00	1.43	4.44	45.49	-0.22	1.42	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1741	864.70	2.607	-0.891	4956.6	500.00	1.43	4.44	45.49	-0.15	1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1742	865.20	2.608	-0.890	4956.6	500.00	1.43	4.44	45.49	-0.07	1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1743	865.69	2.609	-0.890	4956.6	500.00	1.43	4.44	45.50	-0.01	1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1744	866.19	2.610	-0.889	4956.6	500.00	1.43	4.44	45.50	0.05	1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1745	866.68	2.610	-0.889	4956.6	500.00	1.43	4.44	45.50	0.13	1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1746	867.18	2.611	-0.888	4956.6	500.00	1.43	4.44	45.50	0.21	1.42	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1747	867.67	2.612	-0.887	4956.6	500.00	1.43	4.44	45.50	0.28	1.41	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1748	868.17	2.613	-0.886	4956.6	500.00	1.43	4.44	45.50	0.35	1.39	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1749	868.67	2.613	-0.885	4956.5	500.00	1.43	4.44	45.50	0.42	1.37	-55.	-57.	2337.	-2334.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-V 1/SEC	L-P 1/SEC	R-V FT/SEC	R-P RAD/SEC	S	TAU	K-T DEG
0.1750	869.16	2.614	-0.905	4956.5	500.00	1.43	4.44	45.50	0.49	1.35	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1751	869.64	2.615	-0.907	4956.5	500.00	1.43	4.44	45.49	0.55	1.32	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1752	870.15	2.616	-0.908	4956.5	500.00	1.43	4.44	45.49	0.62	1.30	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1753	870.65	2.617	-0.909	4956.5	500.00	1.43	4.44	45.49	0.69	1.26	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1754	871.14	2.618	-0.910	4956.5	500.00	1.43	4.44	45.49	0.76	1.23	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1755	871.64	2.618	-0.911	4956.5	500.00	1.43	4.44	45.49	0.83	1.19	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1756	872.14	2.619	-0.912	4956.5	500.00	1.43	4.44	45.49	0.89	1.15	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1757	872.63	2.620	-0.913	4956.5	500.00	1.43	4.44	45.48	0.92	1.10	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1758	873.13	2.621	-0.914	4956.4	500.00	1.43	4.44	45.49	0.97	1.06	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1759	873.62	2.622	-0.915	4956.4	500.00	1.43	4.44	45.48	1.02	1.01	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1759	874.12	2.623	-0.916	4956.4	500.00	1.43	4.44	45.48	1.07	0.95	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1760	874.61	2.624	-0.917	4956.4	500.00	1.43	4.44	45.48	1.12	0.90	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1761	875.11	2.625	-0.918	4956.4	500.00	1.43	4.44	45.48	1.15	0.84	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1762	875.60	2.626	-0.919	4956.4	500.00	1.43	4.44	45.48	1.20	0.78	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1763	876.10	2.627	-0.920	4956.4	500.00	1.43	4.44	45.48	1.24	0.72	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1764	876.60	2.628	-0.921	4956.4	500.00	1.43	4.44	45.49	1.27	0.65	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1765	877.09	2.630	-0.922	4956.3	500.00	1.43	4.44	45.48	1.31	0.59	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1766	877.59	2.631	-0.924	4956.3	500.00	1.43	4.44	45.49	1.33	0.53	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1767	878.08	2.632	-0.925	4956.3	500.00	1.43	4.44	45.48	1.35	0.46	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1768	878.58	2.633	-0.926	4956.3	500.00	1.43	4.44	45.48	1.38	0.39	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1769	879.07	2.635	-0.927	4956.3	500.00	1.43	4.44	45.48	1.40	0.32	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1770	879.57	2.636	-0.929	4956.3	500.00	1.43	4.44	45.48	1.41	0.25	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1771	880.06	2.637	-0.930	4956.3	500.00	1.43	4.44	45.48	1.42	0.19	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1772	880.56	2.639	-0.931	4956.3	500.00	1.43	4.44	45.49	1.43	0.11	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1773	881.05	2.640	-0.932	4956.2	500.00	1.43	4.44	45.48	1.43	0.04	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1774	881.55	2.642	-0.933	4956.2	500.00	1.43	4.44	45.48	1.43	-0.03	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1775	882.05	2.643	-0.935	4956.2	500.00	1.43	4.44	45.48	1.43	-0.11	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1776	882.54	2.645	-0.936	4956.2	500.00	1.43	4.44	45.48	1.42	-0.18	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1777	883.04	2.646	-0.937	4956.2	500.00	1.43	4.44	45.48	1.41	-0.25	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1778	883.53	2.648	-0.938	4956.2	500.00	1.43	4.44	45.48	1.40	-0.32	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1779	884.03	2.650	-0.940	4956.2	500.00	1.43	4.44	45.49	1.38	-0.39	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1780	884.53	2.651	-0.941	4956.2	500.00	1.43	4.44	45.49	1.35	-0.45	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1781	885.02	2.653	-0.942	4956.2	500.00	1.43	4.44	45.49	1.34	-0.52	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1782	885.52	2.655	-0.943	4956.1	500.00	1.43	4.44	45.50	1.31	-0.59	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1783	886.01	2.657	-0.944	4956.1	500.00	1.43	4.44	45.50	1.28	-0.65	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1784	886.51	2.659	-0.945	4956.1	500.00	1.43	4.44	45.50	1.24	-0.72	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1785	887.00	2.660	-0.947	4956.1	500.00	1.43	4.44	45.50	1.20	-0.78	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1786	887.50	2.662	-0.948	4956.1	500.00	1.43	4.44	45.50	1.17	-0.84	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1787	887.99	2.664	-0.949	4956.1	500.00	1.43	4.44	45.50	1.12	-0.89	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1788	888.49	2.666	-0.950	4956.1	500.00	1.43	4.44	45.50	1.07	-0.95	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1789	888.98	2.668	-0.951	4956.1	500.00	1.43	4.44	45.50	1.02	-1.00	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1790	889.48	2.670	-0.952	4956.1	500.00	1.43	4.44	45.49	0.97	-1.05	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1791	889.97	2.672	-0.953	4956.0	500.00	1.43	4.44	45.49	0.92	-1.10	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1792	890.47	2.674	-0.954	4956.0	500.00	1.43	4.44	45.49	0.86	-1.15	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1793	890.97	2.675	-0.955	4956.0	500.00	1.43	4.44	45.48	0.81	-1.19	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1794	891.46	2.678	-0.956	4956.0	500.00	1.43	4.44	45.48	0.75	-1.23	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1795	891.96	2.680	-0.957	4956.0	500.00	1.43	4.44	45.48	0.69	-1.26	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1796	892.45	2.683	-0.958	4956.0	500.00	1.43	4.44	45.48	0.62	-1.29	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1797	892.95	2.685	-0.958	4956.0	500.00	1.43	4.44	45.47	0.55	-1.32	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1798	893.44	2.687	-0.959	4956.0	500.00	1.43	4.44	45.47	0.49	-1.35	-55.	-57.	2337.	-2334.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-A 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.1799	893.94	2.689	-0.960	4955.9	500.00	1.43	4.44	45.47	0.42	-1.37	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1800	894.43	2.691	-0.961	4955.9	500.00	1.43	4.44	45.47	0.35	-1.39	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1801	894.93	2.693	-0.961	4955.9	500.00	1.43	4.44	45.47	0.28	-1.41	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1802	895.42	2.695	-0.962	4955.9	500.00	1.43	4.44	45.47	0.21	-1.42	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1803	895.92	2.698	-0.963	4955.9	500.00	1.43	4.44	45.48	0.14	-1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1804	896.42	2.700	-0.963	4955.9	500.00	1.43	4.44	45.48	0.07	-1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1805	896.91	2.702	-0.964	4955.9	500.00	1.43	4.44	45.49	-0.00	-1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1806	897.41	2.705	-0.964	4955.9	500.00	1.43	4.44	45.48	-0.08	-1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1807	897.90	2.707	-0.965	4955.9	500.00	1.43	4.44	45.49	-0.15	-1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1808	898.40	2.709	-0.965	4955.9	500.00	1.43	4.44	45.49	-0.22	-1.42	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1809	898.89	2.711	-0.965	4955.8	500.00	1.43	4.44	45.49	-0.29	-1.40	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1810	899.39	2.713	-0.965	4955.9	500.00	1.43	4.44	45.49	-0.36	-1.39	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1811	899.88	2.716	-0.966	4955.8	500.00	1.43	4.44	45.49	-0.43	-1.37	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1812	900.38	2.718	-0.966	4955.8	500.00	1.43	4.44	45.49	-0.50	-1.35	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1813	900.87	2.720	-0.967	4955.8	500.00	1.43	4.44	45.49	-0.56	-1.32	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1814	901.37	2.722	-0.967	4955.8	500.00	1.43	4.44	45.49	-0.63	-1.29	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1815	901.86	2.724	-0.967	4955.8	500.00	1.43	4.44	45.49	-0.69	-1.26	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1816	902.36	2.726	-0.967	4955.7	500.00	1.43	4.44	45.49	-0.75	-1.22	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1817	902.85	2.728	-0.967	4955.7	500.00	1.43	4.44	45.49	-0.81	-1.18	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1818	903.35	2.730	-0.967	4955.7	500.00	1.43	4.44	45.49	-0.87	-1.14	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1819	903.85	2.732	-0.968	4955.7	500.00	1.43	4.44	45.49	-0.93	-1.09	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1820	904.34	2.734	-0.968	4955.7	500.00	1.43	4.44	45.49	-0.98	-1.05	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1821	904.84	2.736	-0.968	4955.7	500.00	1.43	4.44	45.49	-1.03	-1.00	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1822	905.33	2.738	-0.968	4955.7	500.00	1.43	4.44	45.49	-1.08	-0.94	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1823	905.83	2.740	-0.968	4955.7	500.00	1.43	4.44	45.49	-1.13	-0.89	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1824	906.32	2.742	-0.967	4955.7	500.00	1.43	4.44	45.49	-1.17	-0.83	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1825	906.82	2.744	-0.967	4955.6	500.00	1.43	4.44	45.49	-1.21	-0.77	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1826	907.31	2.746	-0.967	4955.6	500.00	1.43	4.44	45.49	-1.25	-0.71	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1827	907.81	2.748	-0.967	4955.6	500.00	1.43	4.44	45.49	-1.28	-0.65	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1828	908.30	2.750	-0.967	4955.6	500.00	1.43	4.44	45.49	-1.31	-0.58	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1829	908.80	2.751	-0.967	4955.6	500.00	1.43	4.44	45.49	-1.34	-0.51	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1830	909.29	2.753	-0.967	4955.6	500.00	1.43	4.44	45.49	-1.36	-0.45	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1831	909.79	2.755	-0.967	4955.6	500.00	1.43	4.44	45.49	-1.38	-0.38	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1832	910.28	2.757	-0.966	4955.6	500.00	1.43	4.44	45.49	-1.40	-0.31	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1833	910.78	2.759	-0.966	4955.6	500.00	1.43	4.44	45.49	-1.41	-0.24	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1834	911.28	2.760	-0.966	4955.5	500.00	1.43	4.44	45.48	-1.42	-0.17	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1835	911.77	2.761	-0.965	4955.5	500.00	1.43	4.44	45.48	-1.43	-0.10	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1836	912.27	2.763	-0.965	4955.5	500.00	1.43	4.44	45.48	-1.43	-0.02	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1837	912.76	2.764	-0.965	4955.5	500.00	1.43	4.44	45.48	-1.43	0.05	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1838	913.26	2.766	-0.965	4955.5	500.00	1.43	4.44	45.48	-1.43	0.12	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1839	913.75	2.767	-0.965	4955.5	500.00	1.43	4.44	45.49	-1.42	0.19	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1840	914.25	2.769	-0.965	4955.5	500.00	1.43	4.44	45.48	-1.41	0.26	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1841	914.74	2.770	-0.965	4955.5	500.00	1.43	4.44	45.48	-1.39	0.33	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1842	915.24	2.771	-0.964	4955.4	500.00	1.43	4.44	45.49	-1.38	0.40	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1843	915.73	2.773	-0.964	4955.4	500.00	1.43	4.44	45.48	-1.35	0.47	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1844	916.23	2.774	-0.964	4955.4	500.00	1.43	4.44	45.48	-1.33	0.54	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1845	916.72	2.775	-0.964	4955.4	500.00	1.43	4.44	45.49	-1.30	0.60	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1846	917.22	2.776	-0.964	4955.4	500.00	1.43	4.44	45.49	-1.27	0.67	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1847	917.72	2.777	-0.964	4955.4	500.00	1.43	4.44	45.49	-1.23	0.73	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1848	918.21	2.778	-0.964	4955.4	500.00	1.43	4.44	45.49	-1.20	0.79	-55.	-57.	2337.	-2334.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.1849	918.71	2.779	-0.964	4955.4	500.00	1.43	4.44	45.49	-1.15	0.85	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1850	919.20	2.780	-0.963	4955.3	500.00	1.43	4.44	45.49	-1.11	0.91	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1851	919.70	2.782	-0.963	4955.3	500.00	1.43	4.44	45.50	-1.07	0.96	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1852	920.19	2.787	-0.963	4955.3	500.00	1.43	4.44	45.50	-1.02	1.01	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1853	920.69	2.783	-0.963	4955.3	500.00	1.43	4.44	45.50	-0.96	1.05	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1854	921.18	2.784	-0.964	4955.3	500.00	1.43	4.44	45.50	-0.91	1.11	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1855	921.68	2.785	-0.964	4955.3	500.00	1.43	4.44	45.50	-0.85	1.15	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1856	922.17	2.786	-0.964	4955.3	500.00	1.43	4.44	45.49	-0.79	1.19	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1857	922.67	2.787	-0.964	4955.3	500.00	1.43	4.44	45.49	-0.73	1.23	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1858	923.16	2.788	-0.964	4955.3	500.00	1.43	4.44	45.49	-0.67	1.27	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1859	923.66	2.789	-0.964	4955.2	500.00	1.43	4.44	45.49	-0.61	1.30	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1860	924.16	2.790	-0.964	4955.2	500.00	1.43	4.44	45.49	-0.54	1.33	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1861	924.65	2.790	-0.965	4955.2	500.00	1.43	4.44	45.49	-0.47	1.35	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1862	925.15	2.791	-0.965	4955.2	500.00	1.43	4.44	45.49	-0.41	1.37	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1863	925.64	2.792	-0.965	4955.2	500.00	1.43	4.44	45.48	-0.34	1.39	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1864	926.14	2.793	-0.966	4955.2	500.00	1.43	4.44	45.48	-0.27	1.41	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1865	926.63	2.794	-0.966	4955.2	500.00	1.43	4.44	45.48	-0.20	1.42	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1866	927.13	2.794	-0.966	4955.2	500.00	1.43	4.44	45.48	-0.12	1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1867	927.62	2.795	-0.967	4955.2	500.00	1.43	4.44	45.48	-0.05	1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1868	928.12	2.795	-0.967	4955.1	500.00	1.43	4.44	45.48	0.02	1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1869	928.61	2.797	-0.968	4955.1	500.00	1.43	4.44	45.48	0.09	1.43	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1870	929.11	2.797	-0.969	4955.1	500.00	1.43	4.44	45.48	0.16	1.42	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1871	929.60	2.798	-0.969	4955.1	500.00	1.43	4.44	45.48	0.23	1.41	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1872	930.10	2.799	-0.970	4955.1	500.00	1.43	4.44	45.48	0.30	1.40	-55.	-57.	2337.	-2334.	-0.	0.	1.
0.1873	930.59	2.800	-0.971	4955.1	500.00	1.43	4.44	45.48	0.37	1.38	-55.	-57.	2337.	-2335.	-0.	0.	1.
0.1874	931.09	2.801	-0.971	4955.1	500.00	1.43	4.44	45.49	0.44	1.36	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1875	931.59	2.801	-0.972	4955.1	500.00	1.43	4.44	45.49	0.51	1.34	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1876	932.08	2.802	-0.973	4955.0	500.00	1.43	4.44	45.49	0.58	1.31	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1877	932.58	2.803	-0.974	4955.0	500.00	1.43	4.44	45.49	0.64	1.28	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1878	933.07	2.804	-0.974	4955.0	500.00	1.43	4.44	45.49	0.70	1.25	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1879	933.57	2.805	-0.975	4955.0	500.00	1.43	4.44	45.49	0.75	1.21	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1880	934.06	2.806	-0.976	4955.0	500.00	1.43	4.44	45.49	0.82	1.17	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1881	934.56	2.806	-0.977	4955.0	500.00	1.43	4.44	45.49	0.88	1.13	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1882	935.05	2.807	-0.978	4955.0	500.00	1.43	4.44	45.49	0.94	1.09	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1883	935.55	2.808	-0.979	4955.0	500.00	1.43	4.44	45.49	0.99	1.04	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1884	936.04	2.809	-0.980	4954.9	500.00	1.43	4.44	45.49	1.03	0.99	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1885	936.54	2.810	-0.981	4954.9	500.00	1.43	4.44	45.49	1.07	0.93	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1886	937.03	2.811	-0.982	4954.9	500.00	1.43	4.44	45.49	1.13	0.88	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1887	937.53	2.812	-0.984	4954.9	500.00	1.43	4.44	45.49	1.18	0.82	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1888	938.03	2.814	-0.985	4954.9	500.00	1.43	4.44	45.49	1.22	0.76	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1889	938.52	2.815	-0.986	4954.9	500.00	1.43	4.44	45.49	1.25	0.70	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1890	939.02	2.815	-0.987	4954.9	500.00	1.43	4.44	45.49	1.29	0.63	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1891	939.51	2.817	-0.988	4954.9	500.00	1.43	4.44	45.49	1.32	0.57	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1892	940.01	2.818	-0.989	4954.9	500.00	1.43	4.44	45.49	1.35	0.50	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1893	940.50	2.819	-0.990	4954.8	500.00	1.43	4.44	45.49	1.37	0.43	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1894	941.00	2.821	-0.992	4954.8	500.00	1.43	4.44	45.49	1.39	0.37	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1895	941.49	2.822	-0.993	4954.8	500.00	1.43	4.44	45.49	1.40	0.30	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1896	941.99	2.823	-0.994	4954.8	500.00	1.43	4.44	45.49	1.42	0.23	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1897	942.48	2.825	-0.995	4954.8	500.00	1.43	4.44	45.49	1.43	0.15	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.1898	942.98	2.826	-0.997	4954.8	500.00	1.43	4.44	45.49	1.43	0.08	-55.	-57.	2336.	-2335.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.1899	943.47	2.828	-0.998	4954.8	500.00	1.43	4.44	45.49	1.43	-0.01	-55.	-57.	2333.	-2335.	-0.	0.	1.
0.1900	943.97	2.829	-0.999	4954.8	500.00	1.43	4.44	45.48	1.43	-0.06	-55.	-57.	2339.	-2335.	-0.	0.	1.
0.1901	944.47	2.831	-1.000	4954.7	500.00	1.43	4.44	45.48	1.43	-0.13	-55.	-57.	2332.	-2335.	-0.	0.	1.
0.1902	944.96	2.832	-1.002	4954.7	500.00	1.43	4.44	45.49	1.42	-0.20	-55.	-57.	2333.	-2335.	-0.	0.	1.
0.1903	945.46	2.834	-1.003	4954.7	500.00	1.43	4.44	45.49	1.41	-0.27	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1904	945.95	2.835	-1.004	4954.7	500.00	1.43	4.44	45.45	1.39	-0.34	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1905	946.45	2.837	-1.005	4954.7	500.00	1.43	4.44	45.48	1.37	-0.41	-55.	-57.	2334.	-2335.	-0.	0.	1.
0.1906	946.94	2.839	-1.006	4954.7	500.00	1.43	4.44	45.48	1.35	-0.48	-55.	-57.	2333.	-2335.	-0.	0.	1.
0.1907	947.44	2.841	-1.008	4954.7	500.00	1.43	4.44	45.45	1.32	-0.55	-55.	-57.	2339.	-2335.	-0.	0.	1.
0.1908	947.93	2.842	-1.009	4954.7	500.00	1.43	4.44	45.49	1.30	-0.61	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1909	948.43	2.844	-1.010	4954.7	500.00	1.43	4.44	45.48	1.26	-0.68	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1910	948.92	2.846	-1.011	4954.6	500.00	1.43	4.44	45.49	1.23	-0.74	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1911	949.42	2.848	-1.012	4954.6	500.00	1.43	4.44	45.49	1.19	-0.80	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1912	949.91	2.850	-1.013	4954.6	500.00	1.43	4.44	45.48	1.15	-0.86	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1913	950.41	2.852	-1.014	4954.6	500.00	1.43	4.44	45.48	1.10	-0.92	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1914	950.90	2.854	-1.016	4954.6	500.00	1.43	4.44	45.49	1.05	-0.97	-55.	-57.	2339.	-2335.	-0.	0.	1.
0.1915	951.40	2.856	-1.017	4954.6	500.00	1.43	4.44	45.49	1.01	-1.02	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1916	951.90	2.858	-1.018	4954.6	500.00	1.43	4.44	45.49	0.95	-1.07	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1917	952.39	2.860	-1.019	4954.6	500.00	1.43	4.44	45.49	0.90	-1.12	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1918	952.89	2.862	-1.020	4954.6	500.00	1.43	4.44	45.49	0.84	-1.16	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1919	953.38	2.864	-1.020	4954.5	500.00	1.43	4.44	45.49	0.78	-1.20	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1920	953.88	2.866	-1.021	4954.5	500.00	1.43	4.44	45.49	0.72	-1.24	-55.	-57.	2339.	-2335.	-0.	0.	1.
0.1921	954.37	2.868	-1.022	4954.5	500.00	1.43	4.44	45.49	0.66	-1.27	-55.	-57.	2334.	-2335.	-0.	0.	1.
0.1922	954.87	2.870	-1.023	4954.5	500.00	1.43	4.44	45.49	0.59	-1.30	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1923	955.36	2.872	-1.024	4954.5	500.00	1.43	4.44	45.49	0.53	-1.33	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1924	955.86	2.875	-1.025	4954.5	500.00	1.43	4.44	45.49	0.46	-1.36	-55.	-57.	2332.	-2335.	-0.	0.	1.
0.1925	956.35	2.877	-1.025	4954.5	500.00	1.43	4.44	45.49	0.39	-1.38	-55.	-57.	2339.	-2335.	-0.	0.	1.
0.1926	956.85	2.879	-1.026	4954.5	500.00	1.43	4.44	45.49	0.32	-1.40	-55.	-57.	2333.	-2335.	-0.	0.	1.
0.1927	957.34	2.881	-1.027	4954.4	500.00	1.43	4.44	45.49	0.25	-1.41	-55.	-57.	2339.	-2335.	-0.	0.	1.
0.1928	957.84	2.883	-1.027	4954.4	500.00	1.43	4.44	45.49	0.18	-1.42	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1929	958.34	2.886	-1.028	4954.4	500.00	1.43	4.44	45.48	0.11	-1.43	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1930	958.83	2.888	-1.029	4954.4	500.00	1.43	4.44	45.49	0.04	-1.43	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1931	959.33	2.890	-1.029	4954.4	500.00	1.43	4.44	45.49	-0.03	-1.43	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1932	959.82	2.892	-1.030	4954.4	500.00	1.43	4.44	45.48	-0.10	-1.43	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1933	960.32	2.894	-1.030	4954.4	500.00	1.43	4.44	45.48	-0.17	-1.42	-55.	-57.	2334.	-2335.	-0.	0.	1.
0.1934	960.81	2.897	-1.030	4954.4	500.00	1.43	4.44	45.48	-0.25	-1.41	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1935	961.31	2.899	-1.031	4954.4	500.00	1.43	4.44	45.49	-0.32	-1.40	-55.	-57.	2339.	-2335.	-0.	0.	1.
0.1936	961.80	2.901	-1.031	4954.3	500.00	1.43	4.44	45.49	-0.38	-1.38	-55.	-57.	2331.	-2335.	-0.	0.	1.
0.1937	962.30	2.903	-1.031	4954.3	500.00	1.43	4.44	45.49	-0.45	-1.36	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1938	962.79	2.905	-1.032	4954.3	500.00	1.43	4.44	45.49	-0.52	-1.33	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1939	963.29	2.907	-1.032	4954.3	500.00	1.43	4.44	45.49	-0.59	-1.31	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1940	963.78	2.910	-1.032	4954.3	500.00	1.43	4.44	45.49	-0.65	-1.28	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1941	964.28	2.912	-1.032	4954.3	500.00	1.43	4.44	45.48	-0.71	-1.24	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1942	964.77	2.914	-1.032	4954.3	500.00	1.43	4.44	45.49	-0.78	-1.20	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1943	965.27	2.916	-1.033	4954.3	500.00	1.43	4.44	45.49	-0.83	-1.16	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1944	965.77	2.918	-1.033	4954.2	500.00	1.43	4.44	45.49	-0.89	-1.12	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1945	966.26	2.920	-1.033	4954.2	500.00	1.43	4.44	45.49	-0.95	-1.08	-55.	-57.	2334.	-2335.	-0.	0.	1.
0.1946	965.76	2.922	-1.033	4954.2	500.00	1.43	4.44	45.49	-1.00	-1.03	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1947	967.25	2.924	-1.033	4954.2	500.00	1.43	4.44	45.49	-1.05	-0.98	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.1948	967.75	2.926	-1.033	4954.2	500.00	1.43	4.44	45.49	-1.10	-0.92	-55.	-57.	2338.	-2335.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	W-N RAD/SEC	W-P RAD/SEC	S	TAU	F-T DEG
0.1949	968.24	2.928	-1.033	4954.2	500.00	1.43	4.44	45.49	-1.16	-0.87	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1950	968.74	2.930	-1.033	4954.2	500.00	1.43	4.44	45.49	-1.19	-0.81	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1951	969.23	2.932	-1.033	4954.2	500.00	1.43	4.44	45.49	-1.22	-0.75	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1952	969.73	2.934	-1.032	4954.2	500.00	1.43	4.44	45.49	-1.26	-0.69	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1953	970.22	2.935	-1.032	4954.1	500.00	1.43	4.44	45.49	-1.29	-0.62	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1954	970.72	2.937	-1.032	4954.1	500.00	1.43	4.44	45.49	-1.32	-0.56	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1955	971.21	2.939	-1.032	4954.1	500.00	1.43	4.44	45.49	-1.35	-0.49	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1956	971.71	2.941	-1.032	4954.1	500.00	1.43	4.44	45.49	-1.37	-0.42	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1957	972.21	2.942	-1.032	4954.1	500.00	1.43	4.44	45.49	-1.39	-0.35	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1958	972.70	2.944	-1.032	4954.1	500.00	1.43	4.44	45.49	-1.40	-0.28	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1959	973.20	2.946	-1.031	4954.1	500.00	1.43	4.44	45.49	-1.42	-0.21	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1960	973.69	2.947	-1.031	4954.1	500.00	1.43	4.44	45.49	-1.43	-0.14	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1961	974.19	2.949	-1.031	4954.0	500.00	1.43	4.44	45.49	-1.43	-0.07	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1962	974.68	2.950	-1.031	4954.0	500.00	1.43	4.44	45.49	-1.43	0.00	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1963	975.18	2.952	-1.031	4954.0	500.00	1.43	4.44	45.49	-1.43	0.07	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1964	975.67	2.953	-1.030	4954.0	500.00	1.43	4.44	45.49	-1.43	0.15	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1965	976.17	2.955	-1.030	4954.0	500.00	1.43	4.44	45.49	-1.42	0.22	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1966	976.66	2.956	-1.030	4954.0	500.00	1.43	4.44	45.49	-1.40	0.29	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1967	977.16	2.957	-1.030	4954.0	500.00	1.43	4.44	45.49	-1.37	0.36	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1968	977.65	2.959	-1.030	4954.0	500.00	1.43	4.44	45.48	-1.37	0.43	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1969	978.15	2.960	-1.029	4953.9	500.00	1.43	4.44	45.48	-1.34	0.49	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1970	978.65	2.961	-1.029	4953.9	500.00	1.43	4.44	45.48	-1.32	0.55	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1971	979.14	2.962	-1.029	4953.9	500.00	1.43	4.44	45.46	-1.29	0.63	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1972	979.64	2.963	-1.029	4953.9	500.00	1.43	4.44	45.48	-1.26	0.69	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1973	980.13	2.964	-1.029	4953.9	500.00	1.43	4.44	45.48	-1.22	0.75	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1974	980.63	2.966	-1.029	4953.9	500.00	1.43	4.44	45.48	-1.18	0.81	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1975	981.12	2.967	-1.029	4953.9	500.00	1.43	4.44	45.48	-1.14	0.87	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1976	981.62	2.968	-1.029	4953.9	500.00	1.43	4.44	45.48	-1.10	0.93	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1977	982.11	2.969	-1.029	4953.9	500.00	1.43	4.44	45.48	-1.05	0.98	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1978	982.61	2.970	-1.029	4953.8	500.00	1.43	4.44	45.48	-1.00	1.03	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1979	983.10	2.971	-1.029	4953.8	500.00	1.43	4.44	45.48	-0.94	1.08	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1980	983.60	2.972	-1.029	4953.8	500.00	1.43	4.44	45.48	-0.89	1.12	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1981	984.09	2.972	-1.029	4953.8	500.00	1.43	4.44	45.49	-0.83	1.17	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1982	984.59	2.973	-1.029	4953.8	500.00	1.43	4.44	45.49	-0.77	1.21	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1983	985.08	2.974	-1.029	4953.8	500.00	1.43	4.44	45.49	-0.71	1.24	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1984	985.58	2.975	-1.029	4953.8	500.00	1.43	4.44	45.49	-0.65	1.28	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1985	986.08	2.976	-1.029	4953.8	500.00	1.43	4.44	45.49	-0.59	1.31	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1986	986.57	2.977	-1.030	4953.6	500.00	1.43	4.44	45.49	-0.52	1.34	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1987	987.07	2.978	-1.030	4953.7	500.00	1.43	4.44	45.49	-0.45	1.36	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1988	987.56	2.978	-1.030	4953.7	500.00	1.43	4.44	45.49	-0.38	1.38	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1989	988.05	2.979	-1.031	4953.7	500.00	1.43	4.44	45.49	-0.31	1.40	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1990	988.55	2.980	-1.031	4953.7	500.00	1.43	4.44	45.49	-0.24	1.41	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1991	989.05	2.981	-1.031	4953.7	500.00	1.43	4.44	45.49	-0.17	1.42	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1992	989.54	2.981	-1.032	4953.7	500.00	1.43	4.44	45.49	-0.10	1.43	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1993	990.04	2.982	-1.032	4953.7	500.00	1.43	4.44	45.49	-0.03	1.43	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1994	990.53	2.983	-1.033	4953.7	500.00	1.43	4.44	45.49	0.05	1.43	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1995	991.03	2.984	-1.033	4953.6	500.00	1.43	4.44	45.49	0.12	1.43	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1996	991.52	2.985	-1.034	4953.6	500.00	1.43	4.44	45.48	0.19	1.42	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1997	992.02	2.985	-1.035	4953.6	500.00	1.43	4.44	45.49	0.26	1.41	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.1998	992.51	2.986	-1.035	4953.6	500.00	1.43	4.44	45.49	0.33	1.39	-55.	-57.	2335.	-2335.	-0.	0.	1.

FLECHETTE GROUND POINT

T SEC	X FT	Y FT	Z FT	V FT/SEC	P RAD/SEC	ALPHA DEG	MACH	PHI DEG	ALPHA DEG	BETA DEG	L-N 1/SEC	L-P 1/SEC	A-N RAD/SEC	W-P RAD/SEC	S	TAU	K-T DEG
0.1999	993.01	2.987	-1.036	4953.6	500.00	1.43	4.44	45.49	0.40	1.39	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.2000	993.50	2.985	-1.037	4953.6	500.00	1.43	4.44	45.45	0.47	1.35	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.2001	994.00	2.988	-1.038	4953.6	500.00	1.43	4.44	45.48	0.53	1.33	-55.	-57.	2339.	-2335.	-0.	0.	1.
0.2002	994.50	2.989	-1.038	4953.6	500.00	1.43	4.44	45.48	0.61	1.30	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.2003	994.99	2.990	-1.039	4953.6	500.00	1.43	4.44	45.48	0.66	1.27	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.2004	995.49	2.991	-1.040	4953.5	500.00	1.43	4.44	45.48	0.73	1.23	-55.	-57.	2334.	-2335.	-0.	0.	1.
0.2005	995.98	2.992	-1.041	4953.5	500.00	1.43	4.44	45.49	0.79	1.20	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.2006	996.48	2.993	-1.042	4953.5	500.00	1.43	4.44	45.49	0.85	1.16	-55.	-57.	2333.	-2335.	-0.	0.	1.
0.2007	996.97	2.994	-1.043	4953.5	500.00	1.43	4.44	45.49	0.90	1.11	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.2008	997.47	2.995	-1.044	4953.5	500.00	1.43	4.44	45.49	0.95	1.07	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.2009	997.96	2.996	-1.045	4953.5	500.00	1.43	4.44	45.49	1.01	1.02	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.2010	998.46	2.997	-1.046	4953.5	500.00	1.43	4.44	45.49	1.06	0.96	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.2011	998.95	2.998	-1.047	4953.5	500.00	1.43	4.44	45.49	1.11	0.91	-55.	-57.	2337.	-2335.	-0.	0.	1.
0.2012	999.45	2.999	-1.049	4953.4	500.00	1.43	4.44	45.49	1.15	0.85	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.2013	999.94	3.000	-1.049	4953.4	500.00	1.43	4.44	45.49	1.19	0.80	-55.	-57.	2337.	-2335.	-0.	0.	1.
0.2014	1000.44	3.001	-1.050	4953.4	500.00	1.43	4.44	45.49	1.23	0.74	-55.	-57.	2337.	-2335.	-0.	0.	1.
0.2015	1000.93	3.002	-1.051	4953.4	500.00	1.43	4.44	45.49	1.25	0.67	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.2016	1001.43	3.003	-1.053	4953.4	500.00	1.43	4.44	45.49	1.30	0.61	-55.	-57.	2333.	-2335.	-0.	0.	1.
0.2017	1001.92	3.004	-1.054	4953.4	500.00	1.43	4.44	45.49	1.33	0.54	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.2018	1002.42	3.005	-1.055	4953.4	500.00	1.43	4.44	45.49	1.35	0.48	-55.	-57.	2330.	-2335.	-0.	0.	1.
0.2019	1002.91	3.007	-1.056	4953.4	500.00	1.43	4.44	45.49	1.37	0.41	-55.	-57.	2334.	-2335.	-0.	0.	1.
0.2020	1003.41	3.008	-1.057	4953.4	500.00	1.43	4.44	45.49	1.39	0.34	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.2021	1003.90	3.009	-1.059	4953.3	500.00	1.43	4.44	45.49	1.41	0.27	-55.	-57.	2337.	-2335.	-0.	0.	1.
0.2022	1004.40	3.011	-1.060	4953.3	500.00	1.43	4.44	45.49	1.42	0.20	-55.	-57.	2337.	-2335.	-0.	0.	1.
0.2023	1004.89	3.012	-1.061	4953.3	500.00	1.43	4.44	45.49	1.43	0.13	-55.	-57.	2334.	-2335.	-0.	0.	1.
0.2024	1005.39	3.014	-1.062	4953.3	500.00	1.43	4.44	45.49	1.43	0.05	-55.	-57.	2333.	-2335.	-0.	0.	1.
0.2025	1005.88	3.015	-1.063	4953.3	500.00	1.43	4.44	45.49	1.43	-0.02	-55.	-57.	2333.	-2335.	-0.	0.	1.
0.2026	1006.38	3.017	-1.065	4953.3	500.00	1.43	4.44	45.49	1.43	-0.09	-55.	-57.	2332.	-2335.	-0.	0.	1.
0.2027	1006.87	3.018	-1.066	4953.3	500.00	1.43	4.44	45.49	1.42	-0.16	-55.	-57.	2334.	-2335.	-0.	0.	1.
0.2028	1007.37	3.020	-1.067	4953.3	500.00	1.43	4.44	45.49	1.41	-0.23	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.2029	1007.86	3.021	-1.069	4953.2	500.00	1.43	4.44	45.49	1.40	-0.30	-55.	-57.	2332.	-2335.	-0.	0.	1.
0.2030	1008.36	3.023	-1.070	4953.2	500.00	1.43	4.44	45.49	1.38	-0.37	-55.	-57.	2334.	-2335.	-0.	0.	1.
0.2031	1008.85	3.025	-1.071	4953.2	500.00	1.43	4.44	45.49	1.36	-0.44	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.2032	1009.35	3.026	-1.072	4953.2	500.00	1.43	4.44	45.49	1.34	-0.51	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.2033	1009.84	3.028	-1.073	4953.2	500.00	1.43	4.44	45.49	1.31	-0.57	-55.	-57.	2337.	-2335.	-0.	0.	1.
0.2034	1010.34	3.030	-1.074	4953.2	500.00	1.43	4.44	45.49	1.28	-0.64	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.2035	1010.83	3.032	-1.076	4953.2	500.00	1.43	4.44	45.49	1.25	-0.70	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.2036	1011.33	3.034	-1.077	4953.2	500.00	1.43	4.44	45.48	1.21	-0.75	-55.	-57.	2334.	-2335.	-0.	0.	1.
0.2037	1011.82	3.035	-1.078	4953.2	500.00	1.43	4.44	45.43	1.17	-0.82	-55.	-57.	2336.	-2335.	-0.	0.	1.
0.2038	1012.32	3.037	-1.079	4953.1	500.00	1.43	4.44	45.48	1.13	-0.86	-55.	-57.	2334.	-2335.	-0.	0.	1.
0.2039	1012.81	3.039	-1.080	4953.1	500.00	1.43	4.44	45.49	1.08	-0.92	-55.	-57.	2333.	-2335.	-0.	0.	1.
0.2040	1013.31	3.041	-1.081	4953.1	500.00	1.43	4.44	45.43	1.02	-0.99	-55.	-57.	2337.	-2335.	-0.	0.	1.
0.2041	1013.80	3.043	-1.082	4953.1	500.00	1.43	4.44	45.48	0.97	-1.04	-55.	-57.	2334.	-2335.	-0.	0.	1.
0.2042	1014.30	3.045	-1.083	4953.1	500.00	1.43	4.44	45.49	0.93	-1.09	-55.	-57.	2333.	-2335.	-0.	0.	1.
0.2043	1014.79	3.047	-1.084	4953.1	500.00	1.43	4.44	45.48	0.89	-1.13	-55.	-57.	2338.	-2335.	-0.	0.	1.
0.2044	1015.29	3.049	-1.085	4953.1	500.00	1.43	4.44	45.48	0.77	-1.17	-55.	-57.	2336.	-2337.	-0.	0.	1.
0.2045	1015.79	3.052	-1.086	4953.1	500.00	1.43	4.44	45.43	0.76	-1.21	-55.	-57.	2334.	-2335.	-0.	0.	1.
0.2046	1016.28	3.054	-1.087	4953.0	500.00	1.43	4.44	45.49	0.70	-1.25	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.2047	1016.78	3.056	-1.089	4953.0	500.00	1.43	4.44	45.49	0.63	-1.26	-55.	-57.	2335.	-2335.	-0.	0.	1.
0.2048	1017.27	3.058	-1.089	4953.0	500.00	1.43	4.44	45.43	0.57	-1.31	-55.	-57.	2339.	-2335.	-0.	0.	1.

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APPENDIX D

FRANKFORD ARSENAL EXPERIMENTAL BALLISTICS FIRING PROGRAM OF FLECHETTES

During the spring and summer of 1974, eleven flechette firings were carried out in the Frankford Arsenal X-ray Ballistic Range. The data was measured from the x-ray plates by Frankford Arsenal personnel and is given in Figure D-1.

The flechette used in this test is very similar to the flechette used in lot 3 of the previous test data. It is assumed that the C.G. and the axial and transverse moments are the same. The C.G. is 0.94 inches from the nose; the axial moment is 0.0107 grain in^2 and the transverse moment is 1.78 grain in^2. It is also assumed that the average spin rate is 2750 rev/sec.

The coordinate axis for the target data is defined as having plot (0,0) coincident with the aim point as established with a laser.

Times of flight were obtained between the first x-ray station and the sixth x-ray station. The baseline for determining the velocity was then a variable where the distance was measured between the flechette C.G. at the first station and at the sixth station.

The data used in the ND analysis is given in Figure D-2. The horizontal and vertical angles for Round 17 are plotted in D-3. In the case of Round 17 and Rounds 35, 23, 21 and 25 the motion was nearly 1d and therefore reductions and analysis could be carried out. The motions, however, on the other rounds were highly 2d and therefore computer fits were not possible. The results for Round 17 are presented herein in order to provide the reader with an example. Figure D-4 contains the original α, β data and the new data as determined by computer fit. The final α, β data is given in Figure D-5 which is used in the basic jump equation.

The trajectory data given in Figure D-1 is fitted on the computer with second degree, third degree and fourth degree polynomials as shown in Figure D-6. The third degree fit was used and a summary of the trajectory data is given in Figure D-7 which is also used in the basic jump equation.

Therefore, the α and β data from Figure D-5 and the trajectory data from Figure D-7 is used with the basic jump equation to provide the results given in Figure D-8.

Figure D-8, therefore, is the final result of the firing program and the jump analysis which shows the agreement between the experimentally determined jump and the jump predicted from the translational ballistics motion parameters as determined in the Frankford Arsenal X-Ray Ballistics Range.

LOT TBR
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Figure D-1

NOSE TO CG IS .940 INCHES

ROUND 17 TIME = 2031.4

FILM	X	Y	Z	ERR	VERT ANGLE	HOR ANGLE	ABS ANGLE	DIRECTION	TIME (SEC)
1	-.0770	-.1363	10.9339	.0366	-2.1564	1.0221	-2.3860	156.4353	.0001912
2	.0633	-.1537	33.0985	.0488	-5.2285	1.9080	-5.5622	161.8446	[illegible]
3	.2172	-.1991	55.5881	-.0085	-5.3931	.8609	-5.4606	172.9318	[illegible]
4	.3963	-.2875	80.8581	-.0066	-1.8322	-.2348	-1.8472	-174.6961	[illegible]
5	.5537	-.3637	103.8862	-.1123	2.4678	-.6549	2.5530	-15.0269	[illegible]
6	.7172	-.4031	126.7605	-.2049	4.6416	-.4234	4.6607	-5.2615	.0022153

AVERAGE VELOCITY = 4752. FT/SEC

ROUND 35 TIME = 2029.5

FILM	X	Y	Z	ERR	VERT ANGLE	HOR ANGLE	ABS ANGLE	DIRECTION	
1	-.1154	-.1406	10.8052	.0301	-.9013	1.2915	-1.5747	126.3521	[illegible]
2	.0313	-.1407	32.8870	.0282	-2.3030	.7494	-2.4216	163.8556	.0005755
3	.1841	-.1711	56.1766	-.0089	-.5331	.9839	-1.1190	119.8155	[illegible]
4	.3364	-.2003	79.3832	-.0499	1.6433	.9455	1.8957	30.2541	.0013842
5	.4957	-.2079	103.6874	-.0435	2.6546	.0061	2.6546	.1327	[illegible]
6	.6364	-.1778	126.4009	-.1251	2.2742	-.1278	2.2778	-3.2511	.0022120

AVERAGE VELOCITY = 4746. FT/SEC

ROUND 23 TIME = 2032.7

FILM	X	Y	Z	ERR	VERT ANGLE	HOR ANGLE	ABS ANGLE	DIRECTION	
1	-.1640	-.1583	13.9515	.0332	.4711	-.0979	.4812	-11.8711	[illegible]
2	.0331	-.1488	33.6919	-.0046	-.0734	-.9900	-.9927	-95.3307	[illegible]
3	.1912	-.1679	57.4623	.0253	-1.4290	-.7920	-1.6336	-152.7508	.0010170
4	.3485	-.1776	80.3243	-.0158	-2.1346	-.0780	-2.1360	-179.9656	[illegible]
5	.4870	-.1607	104.2197	-.1972	-1.1244	.5873	-1.2685	154.1847	.0019146
6	.6360	-.1618	126.4914	-.1822	.2545	1.4928	1.5144	81.2546	[illegible]

AVERAGE VELOCITY = 4695. FT/SEC

ROUND 2 TIME = 2033.8

FILM	X	Y	Z	ERR	VERT ANGLE	HOR ANGLE	ABS ANGLE	DIRECTION	
1	-.0696	-.1638	10.8592	-.0108	-.0094	.3910	-.3911	92.4375	.0001878
2	.0659	-.1694	33.3137	.0769	-.1156	1.2257	-1.2311	96.4906	.0005763
3	.2086	-.1783	55.7173	-.0155	-.1293	3.0829	-3.0856	93.4665	.0009812
4	.3594	-.1917	80.0789	-.0415	.1647	2.8075	2.8123	87.6473	.0013853
5	.5340	-.1704	104.9778	-.0738	.1934	1.6753	1.6864	84.3817	.0018161
6	.7037	-.1529	128.0970	-.1210	.0988	-.6213	.6291	-81.8971	.0022160

AVERAGE VELOCITY = 4804. FT/SEC

ROUND 4 TIME = 2031.1

FILM	X	Y	Z	ERR	VERT ANGLE	HOR ANGLE	ABS ANGLE	DIRECTION	
1	-.0677	-.1514	11.3160	.0155	-.2499	.7507	-.7912	109.6656	.0001935
2	.0986	-.1451	33.9186	.0229	-.6783	.9779	-1.1900	126.1844	.0005800
3	.2521	-.1558	56.6725	-.0153	-.8190	1.3149	-1.5490	123.3238	.0009690
4	.4346	-.1599	82.7313	-.0041	-.2680	1.0164	-1.0511	105.9825	.0014147
5	.6058	-.1533	106.0447	-.0406	.4102	-.0312	.4114	-4.3984	.0018133
6	.7700	-.1338	129.4708	-.0841	.5251	-.0261	.5258	-2.8748	.0022139

AVERAGE VELOCITY = 4848. FT/SEC

ROUND 21 TIME = 1996.1

FILM	X	Y	Z	ERR	VERT ANGLE	HOR ANGLE	ABS ANGLE	DIRECTION	
1	-.1109	-.1486	11.6143	.0261	1.5107	.6916	1.6614	24.8773	.0001986
2	.0324	-.1572	34.3057	-.0144	2.6938	1.9501	3.3240	35.3072	.0005866
3	.16[illegible]2	-.1628	57.3612	.0249	3.3340	2.[illegible]342	3.9561	32.9843	.0009634
4	.[illegible]396	-.1387	81.8297	.0067	1.3399	1.3983	1.9363	46.7553	.0013992
5	.4950	-.0898	105.2557	-.1631	-.2921	.2987	-.4178	135.9067	.0017996
6	.6488	-.0326	128.1421	-.1071	-2.8296	-.7241	-2.9205	-167.5708	.0021912

AVERAGE VELOCITY = 4865. FT/SEC

ROUND 5 TIME = 2031.8

Figure D-1 (continued)

FILM	X	Y	Z	ERR	VERT ANGLE	HOR ANGLE	ABS ANGLE	DIRECTION	
1	-.0504	-.1666	11.1459	.0056	2.1431	1.4189	2.5695	33.8883	.0001939
[illegible]	[illegible]	[illegible]	33.4874	.0364	5.7425	2.1260	6.1186	20.4972	[illegible]

FILM	X	Y	Z	ERR	VERT ANGLE	HOR ANGLE	ABS ANGLE	DIRECTION	
2	.0500	-.1578	33.4674	.0364	5.7425	2.1260	6.1186	20.4972	[illegible]
3	.1923	-.1892	56.1273	.0102	6.8876	2.5060	7.3220	20.1627	[illegible]
4	.3561	-.1145	81.4707	.0145	4.2813	2.0130	4.7279	25.4419	.0019175
5	.5199	-.0263	104.7454	-.0145	-.2779	.3683	-.4614	128.5056	.0018225
6	.6580	.0264	127.6880	-.0529	-4.0700	-.8014	-4.1477	-170.8303	.0022252

AVERAGE VELOCITY = 4788. FT/SEC

ROUND 25 TIME = 2030.1

FILM	X	Y	Z	ERR	VERT ANGLE	HOR ANGLE	ABS ANGLE	DIRECTION	
1	-.1253	-.1501	10.9129	.0343	.8746	1.5046	1.7401	60.5253	.0001431
2	-.0116	-.1466	32.7991	.0480	1.6006	4.6882	4.9515	72.0126	.0005905
3	.1336	-.1408	56.3469	.0465	1.9755	5.8165	6.1386	72.1167	.0009173
4	.3220	-.1226	79.1642	-.0435	.5627	4.4618	4.5637	78.7452	.0014012
5	.5126	-.0865	103.3855	-.1231	.2195	1.1622	1.1827	80.2229	.0016299
6	.6850	-.0297	125.5950	-.2131	-.7632	-2.0623	-2.1987	-111.5758	.0022230

AVERAGE VELOCITY = 4708. FT/SEC

ROUND 22 TIME = 1981.0

FILM	X	Y	Z	ERR	VERT ANGLE	HOR ANGLE	ABS ANGLE	DIRECTION	
1	-.1164	-.1541	12.0050	.0208	-.5206	-.1123	-.5325	-169.7685	.0002124
2	.0097	-.1676	33.7631	.0128	-.9490	-.9475	-1.3409	-136.6050	.0005776
3	.1557	-.1883	57.4006	.0158	-.5403	-2.7707	-2.8227	-102.1945	.0010159
4	.2767	-.2187	80.5107	-.0006	-.8122	-2.2402	-2.3826	-111.1919	.0014250
5	.3712	-.2176	102.6621	-.2085	-.4078	-1.0202	-1.0986	-113.0768	.0018171
6	.4595	-.2498	123.7467	-.1795	.1003	1.3582	1.3619	86.7690	.0021903

AVERAGE VELOCITY = 4701. FT/SEC

ROUND 20 TIME = 2031.9

FILM	X	Y	Z	ERR	VERT ANGLE	HOR ANGLE	ABS ANGLE	DIRECTION	
1	-.0706	-.1622	10.9858	.0177	.4859	.3060	.5742	32.5670	.0001878
2	.0907	-.1789	33.6055	.0075	.9567	-.4694	1.0746	-26.1987	.0005746
3	.2396	-.2136	57.2682	-.0056	1.1981	-2.2065	2.5103	-62.2175	.0009792
4	.3870	-.2226	80.7394	-.0196	.8300	-1.9860	2.1554	-67.9041	.0013806
5	.5145	-.1923	105.9170	-.0222	-.3738	-.3760	-.5302	-136.3904	.0018111
6	.6307	-.1588	129.1871	-.0959	-1.1776	1.8329	-2.1782	124.1322	.0022090

AVERAGE VELOCITY = 4848. FT/SEC

Figure D-1 (continued)

Figure D-1 (continued)

ROUND 8 TIME = 2030.9

FILM	X	Y	Z	ERR	VERT ANGLE	HOR ANGLE	ABS ANGLE	DIRECTION	
1	-.0750	-.1429	11.0242	.0386	-1.3051	.5355	-1.4106	159.5169	.0001907
2	.0712	-.1516	33.3921	.0514	-2.2015	.5321	-2.2647	168.3413	.0006776
3	.2307	-.1946	55.9890	.0249	.0507	-.3150	.3191	-81.7950	.0009686
4	.4348	-.2324	81.7539	-.0202	2.2448	-2.1247	3.0894	-43.9266	.0014143
5	.5390	-.2384	104.8275	-.0708	3.0944	-.5440	3.1417	-10.0767	.0018135
6	.6706	-.2111	127.9104	-.0998	2.3499	.3856	2.3813	9.4220	.0022128

AVERAGE VELOCITY = 4796. FT/SEC

Figure D-2

R&D PARAMETERS

$d = 0.00587$ ft.

$m = 0.00004573$ slugs

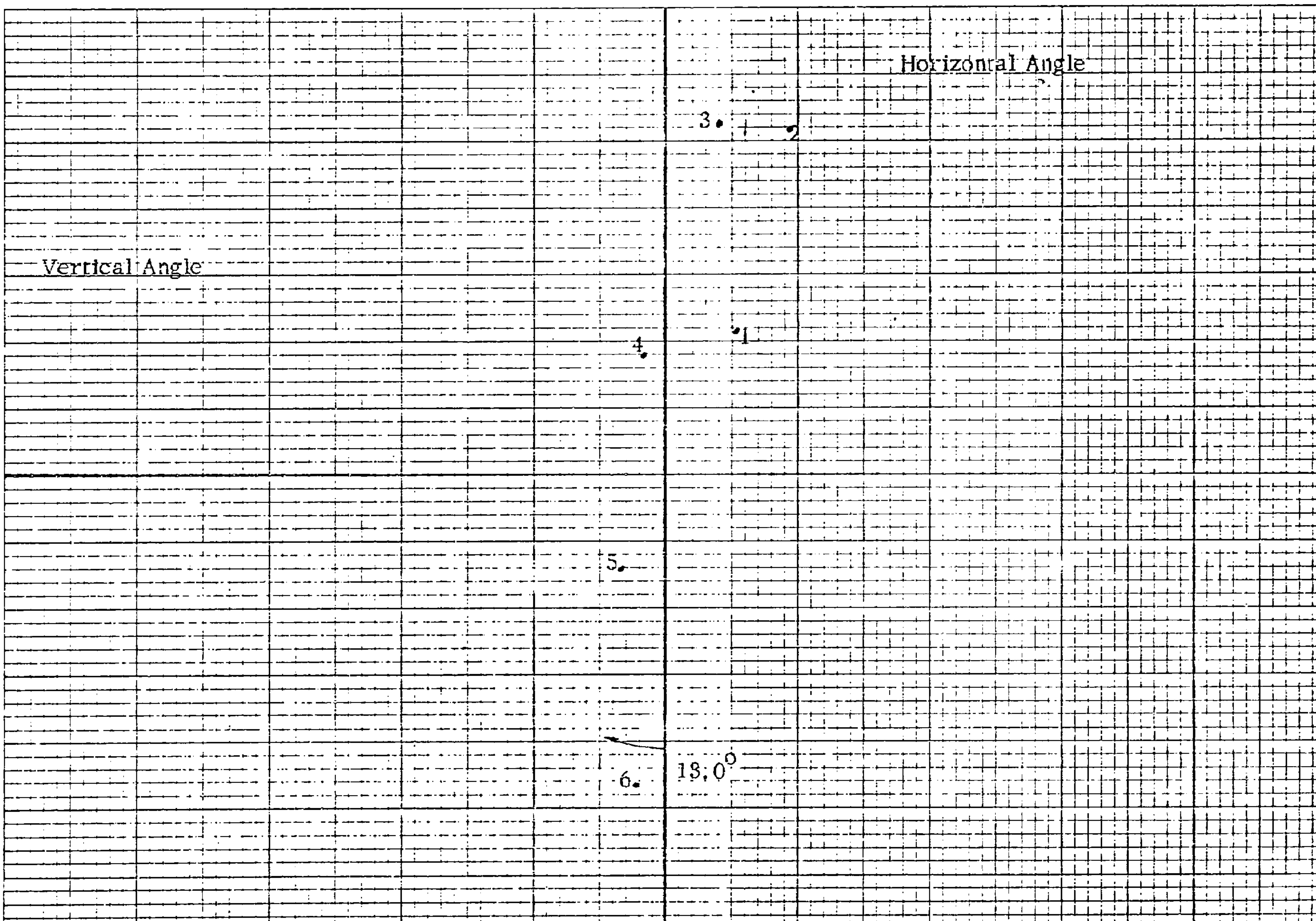
$I_x = 0.000\ 000\ 000\ 330$ slugs-ft^2

$I_y = 0.000\ 000\ 054\ 883$ slugs-ft^2

$p = 17279$ rad/sec

Round 17

Figure D-3



PAGE 2 [illegible]3A0DD JOB 5 AUG 12, 1974 Figure D-4

MODUS 1X

	ALPHA(DEG)	BETA(DEG)
1	-0.215640E 01	0.102210E 01
2	-0.522200E 01	0.155600E 01
3	-0.559310E 01	0.650900E 00
4	-0.185220E 01	-0.254060E 00
5	0.246700E 01	-0.654900E 00
6	0.489160E 01	-0.825800E 00

ANGLE(RAD)	ANGLE(DEG)
-0.282252E 01	-0.161718E 03

	ALPHA(DEG)	BETA(DEG)
1	0.256617E 01	-0.294096E 00
2	0.556511E 01	-0.171605E 00
3	[illegible] 01	0.274247E 00
4	0.166667E 01	0.797570E 00
5	-0.254667E 01	-0.152240E 00
6	-0.454014E 01	-0.165593E 01

EXIT FROM JOB AT 1220
CURRENT JOB TIME 9.7 SEC
// FIN

TOTAL JOB TIME 11.3 SECS. 2 TOTAL PAGE(S)

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RUNS 17

Figure 4 (continued)

TIME	ALPHA(NEW)
0.1913000E-03	0.2560017E 01
0.3792000E-03	0.3565311E 01
0.9727000E-03	0.5570950E 01
0.1415000E-02	0.1068067E 01
0.1616000E-02	-0.2548067E 01
0.2218000E-02	-0.3454014E 01

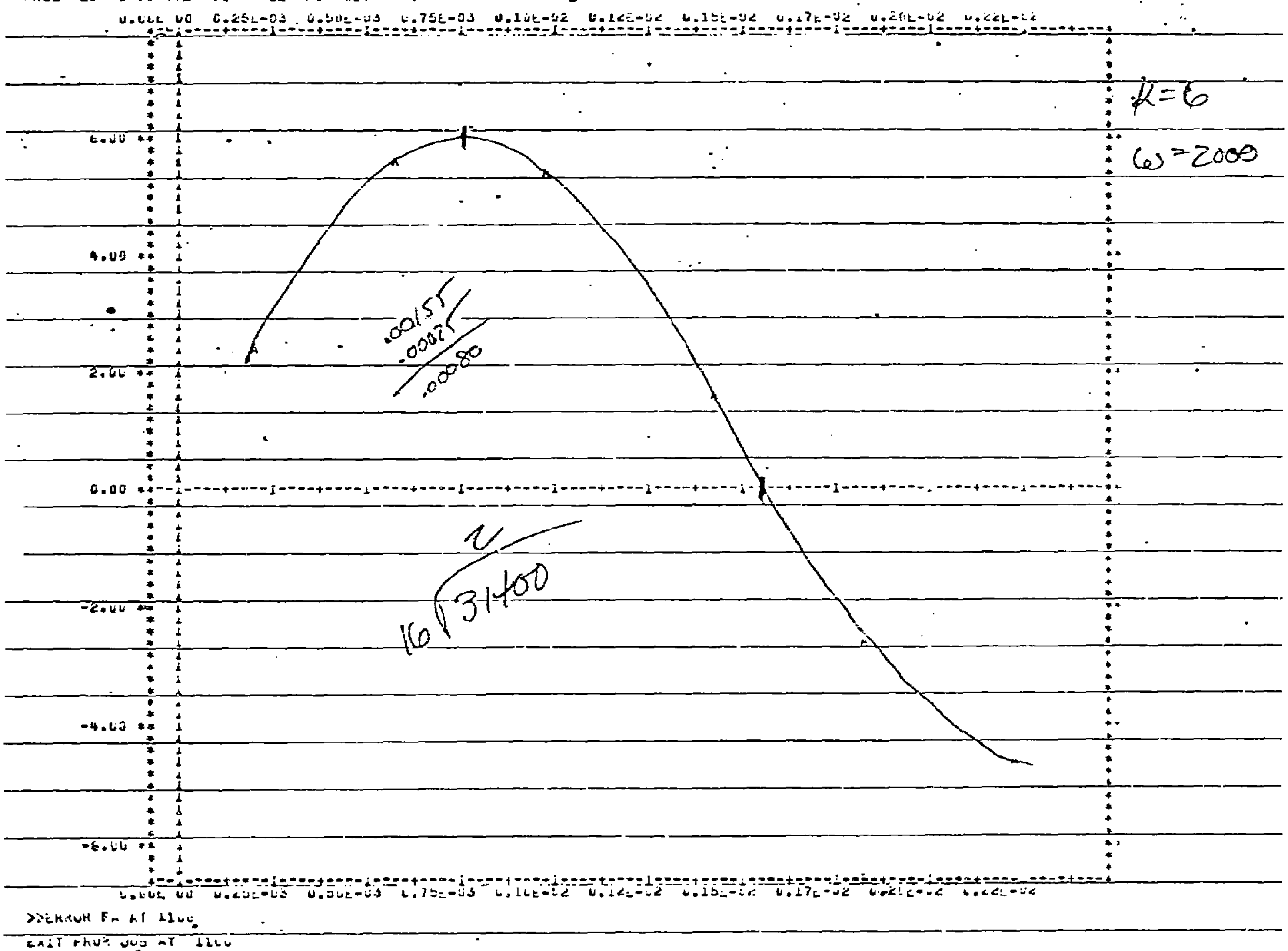

Figure D-4 (continued)

Figure D-4 (continued)

TIME	ALPHA(NEW)
0.000000E 00	0.2300017E 01
0.357900E-03	0.5503111E 01
0.761400E-03	0.5390956E 01
0.122389E-02	0.1000037E 01
0.162689E-02	-0.2543067E 01
0.202699E-02	-0.4540014E 01

APPROXIMATIONS

K1	L1	M1	E1
0.600000E 01	0.000000E 00	0.200000E 04	0.000000E 00

ITER	K1	L1	M1	D1	SDS.
8	0.653643E 01	-0.159249E 03	0.202000E 04	-0.120470E 01	0.154152E-01

Figure D-4 (continued)

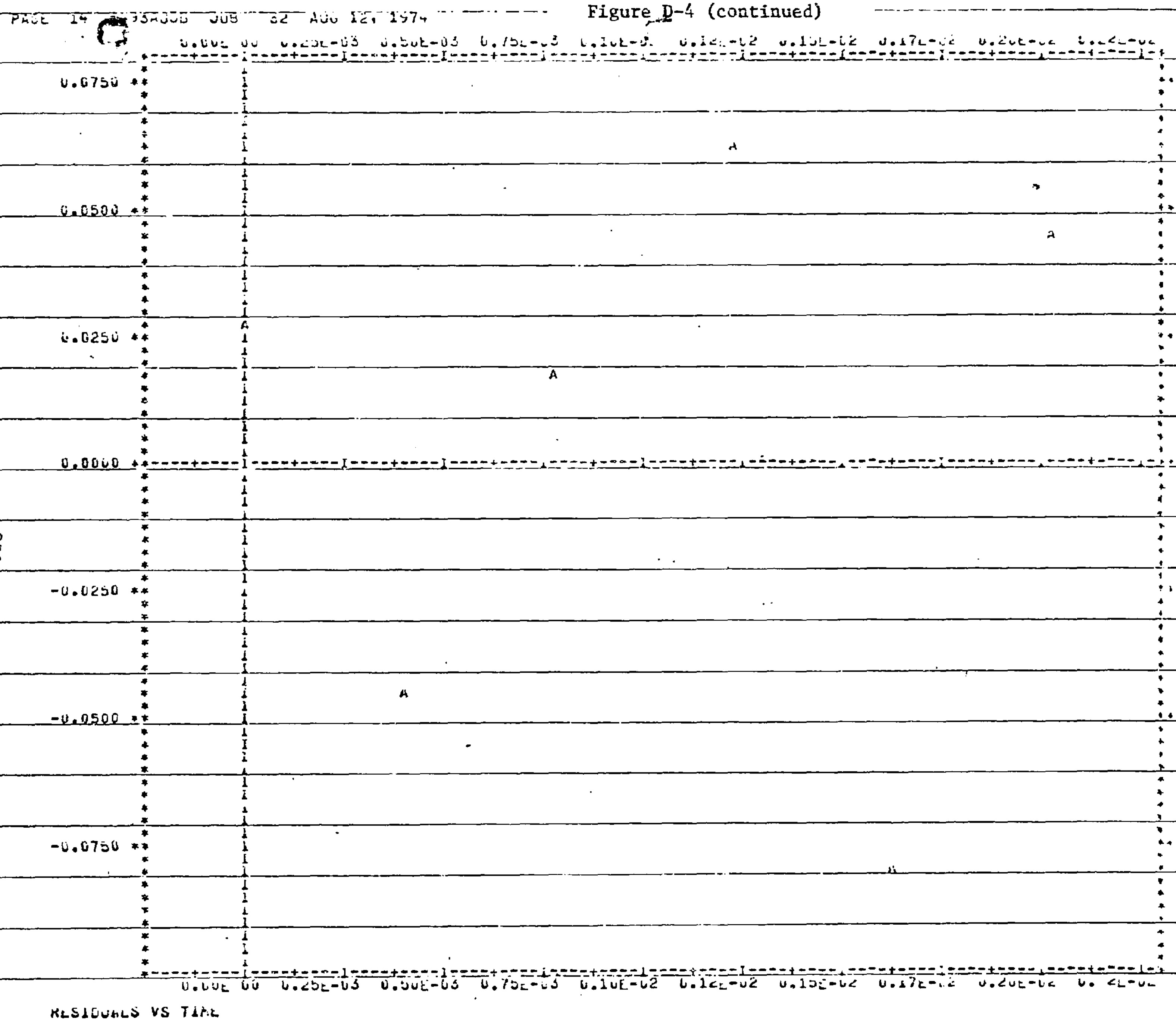

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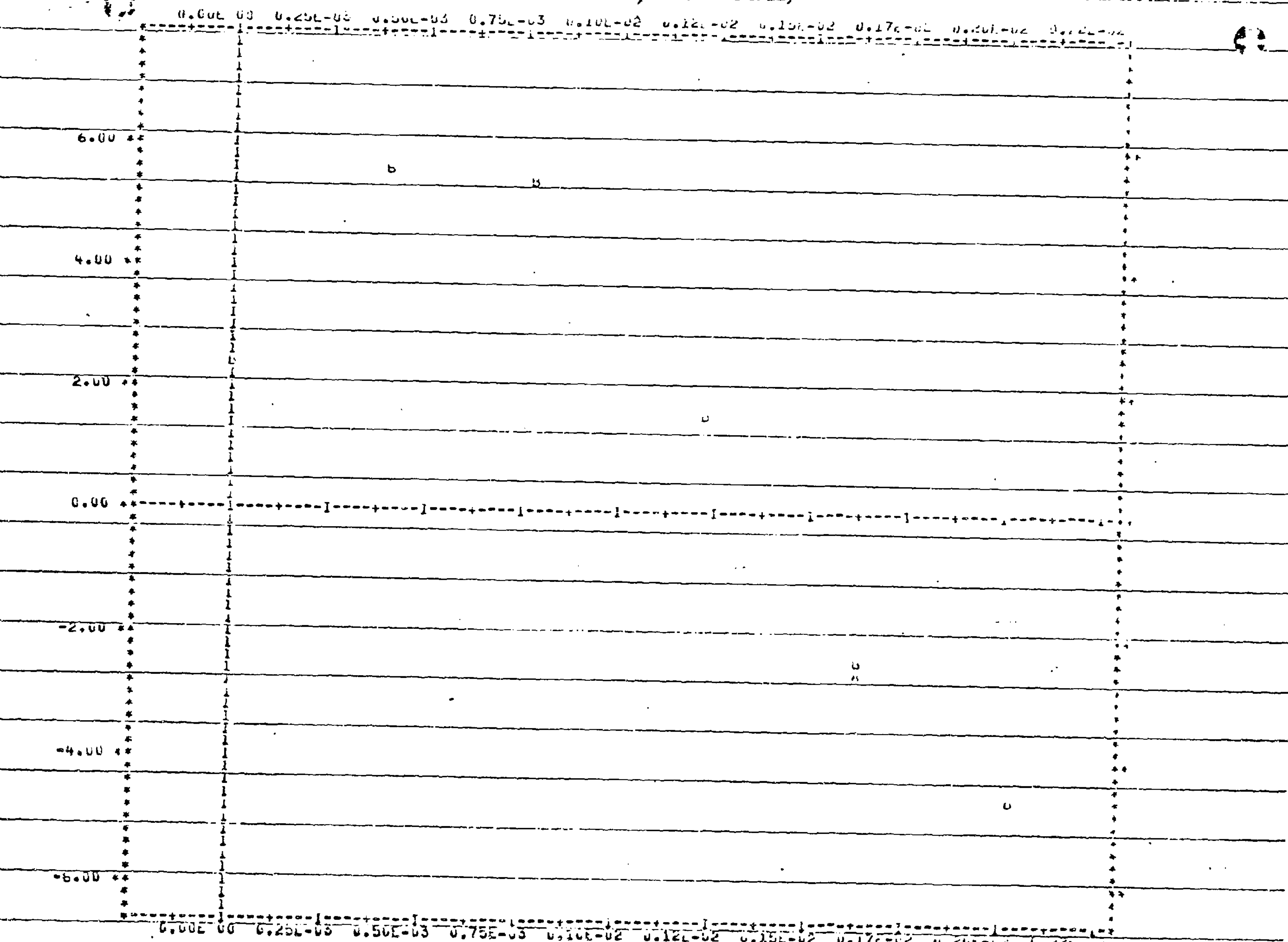
Figure D-4 (continued)



DATA (A) AND FIT (B) VS TIME

ROUND 17

Figure D-5

T	A	B	ALPHA	DA	DB	DALPHA
0.000191	-2.2214	0.7352	2.3399	-198.1504	65.5778	208.7700
0.000291	-3.2863	1.0876	3.4615	-172.3991	57.0554	181.5951
0.000391	-4.1853	1.3851	4.4086	-140.5085	46.5012	148.0033
0.000491	-4.8876	1.6175	5.1483	-103.9553	34.4039	109.5004
0.000591	-5.3748	1.7775	5.6573	-64.3590	21.2996	67.7920
0.000691	-5.6225	1.8608	5.9225	-23.4107	7.7478	24.6594
0.000791	-5.6398	1.8665	5.9406	17.1974	-5.6915	-18.1147
0.000891	-5.4292	1.7968	5.7188	55.8395	-18.4800	-58.8180
0.000991	-5.0065	1.6569	5.2735	91.0203	-30.1231	-95.8754
0.001091	-4.3953	1.4546	4.6297	121.4303	-40.1873	-127.9075
0.001191	-3.6261	1.2000	3.8195	145.9939	-48.3166	-153.7814
0.001291	-2.7349	0.9051	2.8808	163.9044	-54.2441	-172.6473
0.001391	-1.7614	0.5829	1.8554	174.6488	-57.7999	-183.9648
0.001491	-0.7475	0.2474	0.7874	178.0187	-58.9152	-187.5144
0.001591	0.2647	-0.0876	-0.2789	174.1094	-57.6214	-183.3966
0.001691	1.2346	-0.4086	-1.3004	163.3067	-54.0462	-172.0176
0.001791	2.1243	-0.7030	-2.2376	146.2620	-48.4053	-154.0638
0.001891	2.9005	-0.9599	-3.0552	123.8577	-40.9906	-130.4645
0.001991	3.5355	-1.1701	-3.7241	97.1649	-32.1567	-102.3478
0.002091	4.0081	-1.3265	-4.2219	67.3933	-22.3038	-70.9881
0.002191	4.3044	-1.4245	-4.5340	35.8394	-11.8610	-37.7511
0.002291	4.4187	-1.4621	-4.6536	3.8305	-1.2677	-4.0348
0.002391	4.3500	-1.4396	-4.5820	-27.3295	9.0447	28.7873
0.002491	4.1088	-1.3598	-4.3279	-56.4113	18.6693	59.4203
0.002591	3.7096	-1.2277	-3.9074	-82.3082	27.2399	86.6987
0.002691	3.1734	-1.0502	-3.3427	-104.0767	34.4441	109.6283
0.002791	2.5262	-0.8360	-2.6609	-120.9689	40.0346	127.4216
0.002891	1.7974	-0.5949	-1.8933	-132.4570	43.8366	139.5224
0.002991	1.0191	-0.3373	-1.0735	-138.2473	45.7529	145.6216
0.003091	0.2241	-0.0742	-0.2361	-138.2854	45.7655	145.6618
0.003191	-0.5550	0.1837	0.5846	-132.7499	43.9335	139.8309

Figure D-6

17 X.

SECOND DEGREE
POLYNOMIAL COEFFICIENTS

C1 = -.1[illegible]58

C2 = .3[illegible]75

C3 = [illegible]9869

THE PROBABLE ERROR OF FIT IS [illegible]24

THIRD DEGREE
POLYNOMIAL COEFFICIENTS

C1 = -.1441[illegible]

C2 = .34[illegible]4

C3 = [illegible]397[illegible]

C4 = -.[illegible]

$$X = -0.1441 + 0.3404t + 0.0398t^2 - 0.0083t^3$$

$$\dot{X} = 0.3404 + 0.0796t - 0.0249t^2$$

THE PROBABLE ERROR OF FIT IS [illegible]20

FOURTH DEGREE
POLYNOMIAL COEFFICIENTS

C1 = -[illegible].134512

C2 = .277[illegible]

C3 = .[illegible]1[illegible]8

C4 = -[illegible].079658

C5 = [illegible]14837

Figure D-6 (continued)

17Y

SECOND DEGREE
POLYNOMIAL COEFFICIENTS

C1 = -[illegible].1[illegible]7642

C2 = -[illegible].[illegible]63

C3 = -[illegible].[illegible]4147

THE PROBABLE ERROR OF FIT IS [illegible].[illegible]136

THIRD DEGREE
POLYNOMIAL COEFFICIENTS

C1 = -[illegible].1[illegible]5142

C2 = .13[illegible]24

C3 = -[illegible].2[illegible]1245

C4 = [illegible].[illegible]62838

$$Y = -0.1551 + 0.1359t - 0.2512t^2 + 0.0628t^3$$

$$\dot{Y} = 0.1359 - 0.5024t + 0.1884t^2$$

THE PROBABLE ERROR OF FIT IS [illegible].[illegible]037

FOURTH DEGREE
POLYNOMIAL COEFFICIENTS

C1 = -.13[illegible]71

C2 = .1[illegible]3

C3 = -[illegible].[illegible]14

C4 = -[illegible].[illegible]5[illegible]68[illegible]

C5 = [illegible].[illegible]27541

Figure D-7

17

V = 4752

$\times 10^{-3}$	X	Y	S	DX	DY	DS
0.000000	-0.012008	-0.012925	0.017642	0.028367	0.011325	0.030544
0.100000	-0.009139	-0.011997	0.015081	0.029039	0.007295	0.029912
0.200000	-0.006218	-0.011455	0.013029	0.029610	0.003580	0.029826
0.300000	-0.003219	-0.011270	0.011721	0.030170	0.000178	0.030170
0.400000	-0.000175	-0.011409	0.011411	0.030688	-0.002910	0.030826
0.500000	0.002918	-0.011842	0.012196	0.031165	-0.005683	0.031679
0.600000	0.006056	-0.012536	0.013922	0.031600	-0.008143	0.032632
0.700000	0.009236	-0.013460	0.016324	0.031993	-0.010289	0.033607
0.800000	0.012454	-0.014583	0.019177	0.032345	-0.012120	0.034542
0.900000	0.015704	-0.015873	0.022329	0.032656	-0.013638	0.035389
1.000000	0.018983	-0.017300	0.025684	0.032925	-0.014842	0.036116
1.100000	0.022288	-0.018831	0.029178	0.033153	-0.015731	0.036696
1.200000	0.025612	-0.020436	0.032766	0.033339	-0.016307	0.037113
1.300000	0.028954	-0.022082	0.036414	0.033483	-0.016569	0.037358
1.400000	0.032308	-0.023739	0.040092	0.033586	-0.016516	0.037428
1.500000	0.035670	-0.025375	0.043775	0.033648	-0.016150	0.037323
1.600000	0.039036	-0.026959	0.047443	0.033668	-0.015470	0.037052
1.700000	0.042402	-0.028458	0.051067	0.033647	-0.014475	0.036628
1.800000	0.045764	-0.029843	0.054635	0.033584	-0.013167	0.036073
1.900000	0.049117	-0.031081	0.058125	0.033479	-0.011545	0.035414
2.000000	0.052458	-0.032142	0.061522	0.033333	-0.009608	0.034690
2.100000	0.055783	-0.032993	0.064809	0.033146	-0.007358	0.033953
2.200000	0.059086	-0.033603	0.067973	0.032917	-0.004794	0.033264
2.300000	0.062365	-0.033941	0.071002	0.032647	-0.001915	0.032703
2.400000	0.065614	-0.033975	0.073889	0.032335	0.001277	0.032360
2.500000	0.068830	-0.033675	0.076626	0.031981	0.004783	0.032337
2.600000	0.072009	-0.033008	0.079214	0.031586	0.008604	0.032737
2.700000	0.075146	-0.031944	0.081654	0.031150	0.012738	0.033654
2.800000	0.078237	-0.030450	0.083954	0.030672	0.017186	0.035159
2.900000	0.081279	-0.028496	0.086130	0.030153	0.021949	0.037295
3.000000	0.084267	-0.026050	0.088201	0.029592	0.027025	0.040075

CORE USAGE OBJECT CODE= 1720 BYTES,ARRAY AREA= 868 BYTES,TOTAL AREA AVAILABLE= 86112 BYTES

DIAGNOSTICS NUMBER OF ERRORS= 0, NUMBER OF WARNINGS= 0, NUMBER OF EXTENSIONS= 0

COMPILE TIME= 0.08 SEC,EXECUTION TIME= 0.15 SEC, WATFIV - VERSION 1 LEVEL 3 MARCH 1971 DATE= 74/225

Table D-8

DISPERSION ANALYSIS
(127 ft. Target)

ROUND	Position Downrange (ft)	Initial Conditions u_o (ft/sec)	p_o (rad/sec)	$\vec{S}_o$ (ft)	$\dot{\vec{S}}_o$ (ft/sec)	$\vec{\alpha}_o$ (deg)	$\dot{\vec{\alpha}}_o$ (rad/sec)	Frankford Dispersion $\overrightarrow{\text{mils}}$	Frankford Dispersion |mils|	6-D Dispersion $\overrightarrow{\text{mils}}$	6-D Dispersion |mils|
17	1	4752	17279	-0.006208 -0.011455i	0.029610+ 0.003580i	0.7352- 2.2214i	65.6- 198.2i	0.3758 +0.00921	0.3739	-0.087 +0.251i	0.2657
	3			0.006056- 0.012536i	0.031600- 0.008143i	1.7775- 3.3708i	21.3- 64.4i			-0.019 +0.146	0.1472
	5			0.018983- 0.017300i	0.032925- 0.014842i	1.6569- 5.0065i	- 30.1 + 91.0i			0.032- 0.086i	0.0918
	7			0.032308- 0.023739i	0.033586- 0.016516i	0.5829- 1.7614i	- 57.8 +174.6i			0.091- 0.225i	0.2427
21	1	4865	17279	-0.009130 -0.012263i	0.029123- 0.004831i	1.1027+ 1.1028i	73.6+ 73.6i	0.0667+ 0.0683i	0.0955	-0.098 -0.086i	0.1304
	3			0.002832- 0.013482i	0.030624- 0.001223i	2.3922+ 2.3925i	34.5+ 34.5i			-0.035 -0.027i	0.0442
	5			0.015317- 0.013208i	0.031733- 0.002633i	2.5669+ 2.5672i	- 19.7 - 19.7i			0.022+ 0.020i	0.0297
	7			0.028167- 0.011342i	0.032451+ 0.006737i	1.5643+ 1.5644i	- 64.1 - 64.1i			0.106+ 0.084i	0.1352
23	1	4696	17279	-0.009095 -0.012963i	0.030700+ 0.000724i	-0.0187 +0.6239i	0.9- 29.2i	0.1900+ 0.0767i	0.2049	-0.007 +0.007i	0.0099
	3			0.003109- 0.013058i	0.030350- 0.001001i	0.0085- 0.2842i	1.4- 47.1i			0.170+ 0.061i	0.1806
	5			0.015208- 0.013608i	0.030175- 0.001558i	0.0403- 1.3458i	1.2- 40.6i			0.005+ 0.034i	0.0344
	7			0.027273- 0.014148i	0.030176- 0.000948i	0.0574- 1.9201i	- 0.2 - 5.1i			0.019+ 0.008i	0.0206
25	1	4708	17279	-0.010197 -0.012496i	0.018419+ 0.000672i	1.6128+ 0.5056i	174.1+ 54.6i	0.0450+ 0.1467i	0.1534	-0.201 -0.080i	0.2163
	3			-0.000791 -0.012241i	0.028081+ 0.000818i	4.8205+ 1.5112i	97.0+ 30.4i			-0.137 -0.016i	0.1379
	5			0.011842- 0.011667i	0.034550+ 0.002275i	5.8206+ 1.8247i	- 11.1 - 3.5i			-0.040 -0.008i	0.0408
	7			0.026424- 0.010247i	0.037827+ 0.005044i	4.4261+ 1.3875i	- 104.6 - 32.8i			0.154+ 0.041i	0.1594
35	1	4746	17279	-0.009245 -0.011629i	0.031137+ 0.002960i	0.2731- 1.5468i	10.1- 56.9i	0.1675+ 0.0150i	0.168	-0.027 +0.060i	0.0658
	3			0.003296- 0.011988i	0.031503- 0.004020i	0.3742- 2.1193i	- 1.9+ 10.6i			-0.007 +0.003i	0.0076
	5			0.015908- 0.014258i	0.031500- 0.006690i	0.1959- 1.1094i	- 12.7 + 71.8i			0.043- 0.100i	0.1089
	7			0.028446- 0.016681i	0.031129- 0.004780i	-0.1344 +0.7614i	- 14.2 + 80.5i			0.050- 0.087i	0.1003

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